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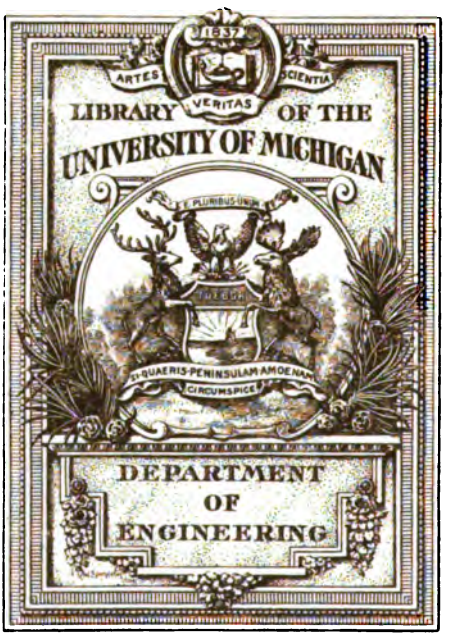

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A. D. GREATOREX, M.INST.C.E.

PRESIDENT, 1911—1912.

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VOLUME 1911–2

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OF THE

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXXVIII. 1911-1912

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Institution*)

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C. F. WIKE, M. Inst. C.E., City Engineer, Sheffield.

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W. NISBET BLAIR, M. Inst. C.E., Borough Engineer, St. Pancras (retires 1913).
J. PATON, Borough Engineer, Plymouth (retires 1914).
A. D. GREATOREX, M. Inst. C.E., West Bromwich (retires 1915).

District Representatives.

Scottish District.—J. YOUNG, Burgh Surveyor, Ayr.
Irish District.—R. H. DORMAN, M. Inst. C.E., County Surveyor, Armagh.
North Eastern District.—E. B. MARTIN, A.M. Inst. C.E., Borough Engineer, Rotherham [Bridlington.
" " " E. R. MATTHEWS, A.M. Inst. C.E., Borough Surveyor,
North Western District.—J. S. BRODIE, M. Inst. C.E., Borough Engineer, Blackpool [Birkenhead.
" " " C. BROWNRIDGE, M. Inst. C.E., Borough Engineer,
Eastern District.—W. H. PRESCOTT, M. Inst. C.E., Surveyor, Urban District Council, Tottenham. [sex Co.
" " H. T. WAKELAM, M. Inst. C.E., County Engineer, Middle-
Metropolitan.—N. SCORGIE, M. Inst. C.E., Borough Engineer, Hackney.
" O. E. WINTER, A.M. Inst. C.E., Borough Engineer, Hampstead.
South Western District.—T. MOULDING, M. Inst. C.E., City Engineer, Exeter.
West Midland District.—H. E. STILGOE, M. Inst. C.E., City Engineer, Birmingham.
Southern District.—L. S. McKENZIE, A.M. Inst. C.E., City Engineer, Bristol.
East Midland District.—E. P. HOOLEY, M. Inst. C.E., County Surveyor, Nottingham.
South Eastern District.—J. L. REDFERN, Borough Surveyor, Gillingham.
North Wales District.—J. PRICE EVANS, Surveyor, Rural District Council, Wrexham.
South Wales District.—G. A. PHILLIPS, A.M. Inst. C.E., County Surveyor, Glamorganshire Co.

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Solicitor to the Institution.—A. M. BRAMALL.

Secretary.

THOMAS COLE, A.M. Inst. C.E., 11 Victoria Street, London, S.W.

Assistant Secretary.

HENRY A. GILES, 11 Victoria Street, London, S.W.

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LIST OF DISTRICT OFFICERS,

1912-1913.

VICE-PRESIDENT FOR SCOTLAND: J. BRYCE.
" " " IRELAND: H. A. CUTLER.

DISTRICT.	CHAIRMAN.	REPRESENTATIVE.	HON. SECRETARY.
Scottish	J. Bryce (Partick)	J. Young (Ayr)	D. Ronald (Falkirk)
Irish	W. Collen (Dublin Co.)	R. H. Dorman (Armagh Co.)	M. Sellars (Dundalk)
North Eastern ..	F. Massie (Wakefield)	E. B. Martin (Rotherham) E. R. Matthews (Bridlington)	J. P. Wakeford (Wakefield)
North Western ..	J. A. Brodie (Liverpool)	J. S. Brodie (Blackpool) C. Brownridge (Birkenhead)	A. W. Bradley (St. Helens)
Eastern	A. Fidler (Northampton)	W. H. Prescott (Tottenham) H. T. Wakelam (Middlesex Co.)	E. J. Elford (Southend)
Metropolitan ..	J. P. Barber (Islington)	N. Scorgie (Hackney) O. E. Winter (Hampstead)	N. Scorgie (Hackney)
South Western ..	H. T. Chapman (Somerset Co.)	T. Moulding (Exeter)	T. Moulding (Exeter)
West Midland ..	A. T. Davis (Salop Co.)	H. E. Stilgoe (Birmingham)	H. Richardson (Birmingham)
Southern	R. Read (Gloucester)	L. S. McKenzie (Bristol)	F. R. Phipps (Basingstoke)
East Midland ..	E. G. Mawbey (Leicester)	E. P. Hooley (Nottinghamshire Co).	R. A. MacBrair (Lincoln)
South Eastern ..	A. Dryland (Surrey Co.)	J. L. Redfern (Gillingham)	F. Roberts (Worthing)
North Wales ..	W. Jones (Colwyn Bay)	J. Price Evans (Wrexham)	J. England (Wrexham)
South Wales ..	W. Harpur (Cardiff)	G. A. Phillips (Glamorganshire Co.)	H. A. Clarke (Briton Ferry)

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PAST PRESIDENTS.

1873–4 1874–5	*LEWIS ANGELL, M. Inst. C.E.
1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	Sir JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	*G. F. DEACON, LL.D., M. Inst. C.E.
1879–80.	*E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881–2.	*W. S. TILL, M. Inst. C.E.
1882–3.	C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	*W. G. LAWS, M. Inst. C.E.
1885–6.	*R. VAWSER, M. Inst. C.E.
1886–7.	J. LOBLEY, M. Inst. C.E.
1887–8.	*J. GORDON, M. Inst. C.E.
1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
1889–90 1890–91	H. P. BOULNOIS, M. Inst. C.E.
1891–2.	T. DE C. MEADE, M. Inst. C.E.
1892–3.	J. CARTWRIGHT, M. Inst. C.E.
1893–4.	*J. T. EAYRS, M. Inst. C.E.
1894–5.	A. M. FOWLER, M. Inst. C.E.
1895–6.	*E. R. S. ESCOTT, M. Inst. C.E.
1896–7.	*F. J. C. MAY, M. Inst. C.E.
1897–8.	Sir ALEX. R. BINNIE, M. Inst. C.E.
1898–9.	O. C. ROBSON, M. Inst. C.E.
1899–1900.	W. HARPUR, M. Inst. C.E.
1900–01.	*C. H. LOWE, M. Inst. C.E.
1901–02.	E. GEORGE MAWBEY, M. Inst. C.E.
1902–03.	T. H. YABBICOM, M. Inst. C.E.
1903–04.	W. WEAVER, M. Inst. C.E.
1904–05.	A. T. DAVIS, M. Inst. C.E.
1905–06.	A. E. COLLINS, M. Inst. C.E.
1906–07.	J. PATTEN BARBER, M. Inst. C.E.
1907–08.	J. A. BRODIE, M. Eng., Wh. Sc., M. Inst. C.E.
1908–09.	E. PURNELL HOOLEY, M. Inst. C.E.
1909–10.	W. NISBET BLAIR, M. Inst. C.E.
1910–11.	J. PATON.
1911–12.	A. D. GREATOREX, M. Inst. C.E.

* Deceased.

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LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

* *Those Members against whose names a star is placed have passed the examination and hold the Testamur of the Institution.*
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P *signifies recipient of Institution's premium.*

HONORARY MEMBERS.

Date of Election and Transfer.		
1911 Nov. 22	BECHMANN, MONS. G. ..	20 Rue d'Athènes, Paris.
1898 Dec. 17	BICKNELL, R. H., M. Inst. C.E.	Local Government Board, Whitehall, S.W.
1911 Nov. 22	BIENVENUE, MONS. M. F.	48 Rue de Rivoli, Paris.
1888 Mar. 3	CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
1911 Nov. 22	COLMET-DAAGE, MONS.	9 Place de l'Hôtel de Ville, Paris.
1904 Feb. 27	COWAN, P. C., D.Sc., M.Inst. C.E.	Chief Engineering Inspector, Local Government Board, Ireland.
1905 Sept. 23	HAWKSLEY, CHARLES, M. Inst. C.E.	30 Great George Street, S.W.
1911 Nov. 22	DE PONTICH, MONS. ..	Directeur Administratif des Travaux, Hôtel de Ville, Paris.
1892 Apr. 23	PUTZEYS, MONS. E... ..	Ingénieur en chef, Directeur de la Ville de Bruxelles.
1890 Sept. 13	ROBINSON, PROFESSOR HY., M. Inst. C.E.	Parliament Mansions, Westminster, S.W.
1874 June 1	TULLOCH, MAJOR H., C.B., R.E.	28 Victoria Street, S.W.
1911 Nov. 22	TUR, MONS. M. P.	9 Place de l'Hôtel de Ville, Paris.
1904 Jan. 23	WILLCOCKS, G. W., C.B., M. Inst. C.E.	Chief Engineering Inspector, Local Government Board, Whitehall, S.W.

MEMBERS.

[M.Inst.M.&Cy.E.].

1910 May 24	ABBOTT, A. E., A.M.Inst.C.E.	Engineer and Surveyor to the Rural District Council, Stratford and Wolverton.
1893 Oct. 21	ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
1894 June 21 R1902 Mar. 22	ABURROW, C., M. Inst. C.E...	515 Consolidated Buildings, Johannesburg, S.A.
1903 May 16	ADAMS, A. E., M. Inst. C.E.	Borough Engineer, Chippenham, Wilts.
P1896 Jan. 18	AITKEN, T., M. Inst. C.E. ..	County Surveyor, Cupar, Fife.

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Date of Election and Transfer.		
A1907 Jan. 19 T1910 Apr. 23	*Aldridge, A. E. W.	Surveyor and Water Engineer to the Urban District Council, Skipton, Yorkshire.
1897 Jan. 16	Allen, A. T...	Surveyor to the Urban District Council, Portslade-by-Sea, Sussex.
1873 May 2 R1884 Jan. 26	*Allen, T. T...	Broad Street, Stratford-on-Avon.
1911 July 5	Allison, A. W.	Burgh Surveyor, Crieff.
1897 June 19	Alves, G.	Surveyor to the Urban District Council, Glastonbury.
AM1909 Oct. 30 T1911 July 29	*Anderson, H. E.	Chief Assistant, Borough Engineer's Office, Lambeth.
1890 June 26	Anderson, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles.
1900 Dec. 15	Anderson, W. V., Assoc. M. Inst. C.E.	City Surveyor, Winchester.
P1906 Apr. 28	Andrew, J.	County Surveyor's Office, County Bldgs., Dumbarton.
G1898 June 30 T1899 Oct. 21	*Andrews, S. P.	Borough Surveyor, Faversham.
G1894 Oct. 20 TP1899 Oct. 21	*Angel, R. J., M. Inst. C.E. ..	Borough Surveyor, Bermondsey, S.E.
1894 May 19	*Angell, J. A., A.M.Inst.C.E.	Surveyor to the Urban District Council, Beckenham, S.E.
1899 June 29	*Anster, J.	Surveyor to the Rural District Council, Guildford.
1880 May 27 R1899 Feb. 25	Armistead, R., Assoc. M. Inst. C.E.	10 Booth Street, Bradford.
1910 Dec. 10	Ashe, A. V.	Town Surveyor, Urban District Council, Tullamore, King's Co., Ireland.
AM1910 June 16 T1911 July 29	Ashurst, J.	Deputy Borough Engineer, Luton.
1900 June 16	Asquith, A.	Surveyor to the Urban District Council, Holyhead.
1890 June 26	Atkinson, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
A1908 June 25 TAM1911 July 29 T1912 Feb. 10	*Baggott, S. C.	Deputy Borough Engineer, Town Hall, Macclesfield.
AM1909 Jan. 23 T1911 July 29	Baines, A. C. V.	Resident Engineer, Klipfontein Irrigation Board, P.O. Klipfontein Siding, Cape Province.
1904 Jan. 23	Baines, C. O.	Surveyor to the Urban District Council, Paignton.
1900 Feb. 10	Bains, G. S. L.	Town Hall, Guildford, West Australia.
AM1908 Feb. 29 T1911 July 29	Bains, T. T.	Surveyor to the Rural District Council, South Shields. 1 The Terrace, East Boldon R.S.O., co. Durham.
1891 Aug. 1 R1903 Feb. 21	Baker, J.	75 High Street, Slough.
1896 June 25	Baldwin, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.
G1891 Aug. 1 T1896 Feb. 22	*Ball, B., A.M. Inst. C.E. ..	Municipal Engineer's Office, Singapore.

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Date of Election and Transfer.		
G1887 Sept. 17 T1898 Feb. 19	*Ball, G., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Bexhill.
A1906 May 26 TAM1909 Dec. 11 T1911 July 29 B1912 Jan. 13	*Ballard, W. E., A.M. Inst. C.E.	Estville, Southam Road, Hall Green, Birmingham.
1879 Oct. 23	Banks, W., A.M. Inst. C.E.	City Surveyor, Rochester.
1887 Mar. 12	BARBER, J. PATTEN, M. Inst. C.E. (*Past President. Member of Council.*)	Borough Engineer, Islington, N. *Chairman*, Metropolitan District.
1910 June 16	Barclay, L. B.	Engineer to the Water of Leith Sewage Commission, 16 Queen Street, Edinburgh.
G1901 Aug. 24 T1906 Apr. 28	*Barker, H. W.	Surveyor to the Urban District Council, Walmer.
1910 Oct. 29	Barlow, E. E.	Borough Engineer, Wisbech.
G1888 Sept. 15 T1892 July 11	*Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
1897 Jan. 16	Barrett, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Staines.
1912 July 11	*Barron, A. D.	Deputy Surveyor, Douglas, Isle of Man. 4 Strathallan Crescent, Douglas.
1899 Jan. 21	Barrs, J. D.	Surveyor to the Urban District Council, Bromyard.
G1903 Jan. 17 T1905 May 27	*Bate, E. M.	Surveyor to the Urban District Council, Frinton-on-Sea.
A1907 May 25 TAM1911 July 29 T1912 Feb. 10	Baxter, J. G. R.	Borough Engineer's Office, Gt. Grimsby.
G1901 June 8 T1903 July 25	*Beacham, W. E.	Town Surveyor, Leek.
1903 May 16	Bean, J. A.	County Surveyor, Northumberland. Moot Hall, Newcastle.
1894 Jan. 13	Beaumont, A.	Surveyor, Yorks, East Riding. County Hall, Beverley.
AM1909 July 17 T1911 July 29	Beaumont, F. G.	Deputy Borough Engineer, Wolverhampton.
1897 Mar. 13	Beaumont, G. E.	Surveyor to the Rural District Coun., Wortley. "Holme Lea," Greenoside, near Sheffield.
G1906 June 28 TAM1911 July 29 T1912 Feb. 10	*Beaumont, R. H.	Surveyor to the Urban District Council, Torpoint, R.S.O., Cornwall.
1897 Mar. 13	Beaumont, T. C.	Surveyor to the Rural District Council, Driffield.
A1904 Sept. 17 TAM1911 July 29 T1912 Feb. 10	Bell, C. D., M.Sc. (Vic.) ..	Surveyor to the Urban District Council, Camborne, Cornwall.
1892 Jan. 16	Bell, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
A1902 Jan. 25 T1906 Dec. 15	*Bell, L. M., M.Inst.C.E. ..	Municipal Engineer, Penang, S.S.
1906 Apr. 28	Bell, T. H.	Surveyor to the Urban District Council, Ramsbottom.
A1906 Dec. 15 TAM1907 Nov. 2 T1911 July 29	Belsher, B. J., A.M.Inst.C.E.	Deputy Borough Engineer, 15 Gt. Alie Street, Stepney.

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1896 Jan. 18	BENNETT, H. M.	Surveyor to the Rural District Council, Keynsham, Bristol.
1912 July 11	BENNETT, W.	Executive Engineer T. L. R. Works, P.W.D. Rangoon.
G1898 Dec. 17 T1900 July 19	*BENNETTS, J. P.	Surveyor to the Urban District Council, Harrow.
G1897 July 31 TA1901 Oct. 19 TAM1911 July 29 T1912 Feb. 10	*BENTLEY, J. H., A.M.Inst.C.E.	Deputy Borough Engineer, Town Hall, Oldham.
1886 Oct. 16 R1896 Jan. 18	BERRINGTON, R. E. W., M. Inst. C.E.	Graisley, Wolverhampton.
G1898 June 30 TA1901 Oct. 19 TAM1907 Nov. 2 T1911 July 29	*BEST, H. STORR, A. M. Inst. C.E.	Chief Assistant Surveyor, Urban District Council, Beckenham.
1892 Mar. 11 R1899 May 6	BESWICK, W. H., Assoc. M. Inst. C.E.	8 Lowther Street, Whitehaven.
1891 June 6 R1912 Jan. 13	BETTANY, F.	Green Bank, High Lane, Burslem.
1902 Mar. 22	BIBBEY, T.	Cheadle, Staffs.
1890 Mar. 29	BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	St. Stephen's House, Victoria Embankment, S.W.
G1893 June 24 TA1902 Nov. 8 TAM1908 Sept. 5 T1911 Apr. 29	*BIRCH, J.	Borough Engineer, East Ham, E.
1896 Nov. 28 R1908 Apl. 25	BIRD, W. F.	The Island, Midsomer Norton.
1897 Jan. 16	BIRKS, E.	39 Myddleton Road, Uxbridge.
P1873 May 2 R1909 Oct. 30	BLACKSHAW, W., Assoc. M. Inst. C.E.	Argyle House, Rowley Park, Stafford.
1910 May 24	BLACKWALL, J. E., A.M.Inst. C.E.	County Surveyor, Cambridgeshire. 61 Sidney Street, Cambridge.
1904 Aug. 5	BLACKWOOD, R.	Burgh Surveyor, Kilmarnock.
1886 June 12	BLAIR, W. N., M.Inst. C.E. (*Past President. Member of Council.*)	Borough Surveyor, St. Pancras.
G1901 Aug. 24 TA1908 Sept. 5 TAM1911 July 29 T1911 Sept. 23	*BLANCHARD, R.	Surveyor to the Urban District Council, Cannock, Staffs.
1903 Oct. 17	BLAND, J. D.	Assistant to Borough Surveyor, Cambridge.
1907 Apr. 27	BLANEY, C.	Borough Surveyor, Newry, Ireland.
1900 Mar. 10	BLOOD, A. T.	Surveyor to the Urban District Council, Hitchin.
1907 May 25	BODDIE, C. L., A.M.Inst.C.E.	County Surveyor, Londonderry.
AM1910 Mar. 12 T1911 July 29	BOLTON, E. E. T.	Engineer to the Urban District Council, Woodhall Spa.
1902 Nov. 8	*BORG, E. A.	Borough Surveyor, Margate.
1904 Feb. 27	BOTTOMLEY, H.	Surveyor to the Urban District Council, Bingley.
1877 May 1	BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	7 Victoria Street, S.W.

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Date of Election and Transfer.		
1898 Mar. 19 R1908 Feb. 21	BOWEN, H. W.	County Surveyor, West Sussex County Council, Horsham.
AM1909 Jan. 23 T1911 July 29	BOWES, T.	County Surveyor's Office, Hatfield, Herts.
1904 Aug. 12	BOWIE, J. McL.	Burgh Surveyor, Maxwelltown, Dumfries.
1898 Oct. 15	BOYLE, J. C.	City Surveyor, Armagh.
1903 May 16	BRADLEY, A. W., M.Inst.C.E.	Borough Engineer, St. Helens, Lancs. *Hon. Sec.*, North Western District.
G1905 Jan. 28 A1907 Mar. 2 T1910 Sept. 17	*BRADLEY, C. G.	Engineer and Surveyor to the Urban District Council, Goole.
1897 Jan. 16	BRADLEY, W. L.	Surveyor to the Urban District Council, Tonbridge.
1911 Sept. 23	BRADSHAW, A. G.	Borough Surveyor and Water Engineer, Lancaster.
G1899 June 10 TA1905 Jan. 28 TAM1908 Dec. 5 T1911 July 29	*BRADSHAW, A. S., A.M. Inst. C.E.	Engineer, P. W. D., Freetown, Sierra Leone.
G1894 Jan. 13 T1896 Oct. 24	*BRADSHAW, F. E. G.	Borough Surveyor, Tamworth.
1891 Aug. 1	BRETT, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.
1891 Aug. 1	BRETTELL, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
1894 Oct. 20	BRIDGES, O. A.	Surveyor to the Urban District Council, Bognor.
AM1911 June 10 T1911 July 29	BRIDGEWATER, A. T.	Borough Engineer's Office, East Ham, E.
1891 Mar. 21	BRIERLEY, J. H., A. M. Inst. C.E.	Borough Surveyor, Richmond, Surrey.
IG1898 June 30 TA1903 June 25 TAM1911 July 29 T1912 Feb. 10	*BRISCOE, J. T.	Deputy Engineer, Council Offices, Enfield.
1901 Dec. 7	BRODIE, J. A., M. Eng., Wh. Sc., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Liverpool. *Chairman*, North Western District.
P1889 Apr. 13	BRODIE, J. S., M. Inst. C.E.. (*Member of Council.*)	Borough Engineer, Blackpool. *District Representative*, North Western District.
1894 Oct. 20	BROOKE, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
A1902 Jan. 25 T1908 Sept. 5	BROOKES, A. E.	County Surveyor, Cornwall. Truro.
1910 July 16	BROOKS, E. J. D.	Chief Engineer to the Transkeran and Ponderland General Councils, General Council Offices, Umtata, Cape Colony.
1884 July 10	BROWN, A., M. Inst. C.E. ..	Borough Engineer, Nottingham.
1898 Jan. 15	BROWN, C., A.M. Inst. C.E..	Engineer to the Urban District Council, Town Hall, Edmonton.
1904 Aug. 25	BROWN, CHAS.	Burgh Surveyor, Hawick.

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Date of Election and Transfer.		
AM1911 Jan. 21 T1911 July 29	*Brown, C. F.	Deputy Water Engineer and Surveyor, Gainsborough, Lincs.
AM1910 May 24 T1911 July 29	*Brown, D. J.	Assistant Surveyor, Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	Brown, F.	Town Engineer, Kroonstad, O.R.C., South Africa.
A1902 Jan. 25 T1910 Jan. 22	Brown, H. A.	Engineer to the Urban District Council, Weston-super-Mare.
1908 Jan. 18	Brown, H. E.	Surveyor to the Urban District Council, Altrincham.
1905 Sept. 23	Brown, H. H. Lane, M. Inst. C.E.	Supervising Engineer, Lucknow, United Provinces, India.
G1894 July 7 T1898 Sept. 3	*Brown, Reginald, A.M. Inst. C.E.	Surveyor to the Urban District Council, Town Hall, Southall Norwood. 21 Old Queen Street, Westminster.
A1910 Apr. 23 TAM1911 July 29 T1912 Feb. 10	Brown, R. D., A.M.Inst.C.E.	City Engineer, St. Catharines, Ontario, Canada.
1893 Mar. 4	*Brownridge, C., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Birkenhead. *District Representative*, North Western District.
1904 Aug. 9	Bruce, J. S.	Burgh Surveyor, Kirriemuir.
G1896 June 25 TAM1911 July 29 T1912 Jan. 13	*Bruce, W.	Chief Assistant, City Engineer's Office, Edinburgh.
1909 Dec. 11	Bryan, W. B., M. Inst. C.E.	Chief Engineer, Metropolitan Water Board, Savoy Court, W.C. Elmstead Wood, Elmstead Lane, Chislehurst.
1901 Feb. 16	Bryce, J., M. Inst. C.E. (*Vice - President, Scotland. Member of Council.*)	Burgh Surveyor, Partick. *Chairman*, Scottish District.
G1889 Feb. 9 T1902 Mar. 22	*Bryning, W. G.	County Surveyor, Yorks, North Riding. Northallerton.
1873 May 2	Buckham, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
1897 July 8 B1902 Mar. 22	Buckley, M. J., Assoc. M. Inst. C.E.	Garrán an Cheoil, Iona Drive, Dublin.
1911 Apr. 29	Buckley, R. H.	Borough Engineer. Mossley.
1897 Feb. 13	Bull, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
A1908 Feb. 29 TAM1910 May 24 T1911 July 29	*Bullough, J. S., A.M.Inst. C.E.	Deputy Borough Engineer, Preston.
1895 Feb. 16	Bunting, T. F.	Borough Surveyor, Maidstone.
1895 Jan. 19	Burden, A. M., B.E., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
1892 Sept. 24	Burgess, S. E., M. Inst. C.E.	Borough Engineer, Middlesbrough.
1900 Apr. 21	Burkitt, J. P., B.E., A.M. Inst. C.E.	County Surveyor, Enniskillen.
1905 Mar. 3	Burn, W., A. M. Inst. C.E...	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
1904 Aug. 6	Burns, D.	Burgh Surveyor, Pollokshaws.
1910 Oct. 29	Burrows, T...	Surveyor to Lathom and Burscough Urban District Council. Lathom, near Ormskirk.
1890 June 7 B1912 Apr. 27	Burslam, R.	18 Moody Street, Congleton.

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Date of Election and Transfer.			
G1895 Jan. 19 T1902 Jan. 25	*Burton, A., A.M. Inst. C.E.	Borough Engineer, Stoke-on-Trent.
A1904 May 28 TAM1909 Apr. 24 T1911 July 29	*Burton, W. E. H., A.M. Inst. C.E.	Chief Engineering Assistant, County Architect's Office, Wakefield.
1897 Jan. 16	Busbridge, T. A.	Surveyor to the Rural District Council, Bower Mount Road. Maidstone.
G1899 June 29 TA1902 Jan. 25 T1904 Feb. 27	*Bush, W. E., A. M. Inst. C.E.	City Engineer, Auckland, New Zealand.
1890 Sept. 13	Butler, W.	Surveyor to the Urban District Council, Fareham.
1899 June 29	Butterworth, A. S., Assoc. M. Inst. C. E.	Municipal Engineer, Port Elizabeth, S. Africa.
G1905 Dec. 9 T1907 Apr. 27	*Butterworth, G. L.	Surveyor to the Rural District Council, Isle of Thanet.
1894 Apr. 6	Caink, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
1891 Dec. 12 R1903 Jan. 17	Cairncross, T. W., Assoc. M. Inst. C.E.	Rosemead Avenue, Cape Town, S.A.
1903 Jan. 17	Calder, W., A. M. Inst. C.E.	City Engineer, Prahran, Victoria.
1912 June 1	Calvert, G	County Road Surveyor, Maud, Aberdeenshire.
1891 Oct. 17	Campbell, A. H., M. Inst. C.E. (*Member of Council.*)	City Engineer, Edinburgh.
1887 Mar. 12	Campbell, K. F., M. Inst. C.E.	Borough Engineer, Huddersfield.
G1906 June 28 T1911 June 10	*Caplen, L.	Surveyor to the Rural District Council, Yeovil, Montacute S O., Somerset.
1888 May 12	Capon, E. R.	Surveyor to the Urban District Council, Epsom.
1890 Oct. 18 R1899 Jan. 21	Card, H...	10 North Street, Lewes.
AM1908 Feb. 29 T1909 Oct. 30	Carey, J. G.	Surveyor to the Urban District Council, Heston and Isleworth. Council House, Hounslow.
1910 Oct. 29	Carr, W. L.	Engineer and Surveyor, Urban District Council, Ruislip-Northwood.
1903 Feb. 21 A1904 May 28 TAM1908 Dec. 5 T1911 July 29	Carter, A. H.	Surveyor to the Urban District Council, Litherland, Liverpool.
	Carter, E. W. A...	Deputy City Surveyor, Gloucester.
1901 June 27	Carter, G. E.	Surveyor to the Rural District Council, Winchester.
1897 June 19 G1892 July 11 TA1901 Dec. 7 T1904 Jan. 23	Carter, G. F.	Surveyor to the Urban District Council, Mexborough.
	*Carter, G. F., M.Inst.C.E... (*Member of Council.*)	Borough Engineer, Croydon.
G1903 Dec. 12 A1907 Mar. 2 TAM1909 June 5 T1911 July 29	*Carter, S. F. R., A.M.Inst. C.E.	Deputy Engineer, The Council House, Hounslow.
1898 Dec. 17	Cartwright, A. S.	Surveyor to the Urban District Council, Wilmslow, Cheshire.

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Date of Election and Transfer.		
1873 May 2	CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	21 Parsons Lane, Bury.
1904 June 26	CARVER, W.	Surveyor to the Rural District Council, Melford. 3 Melford Road, Sudbury, Suffolk.
1895 Mar. 16	CASS, R. W.	Surveyor to the Urban District Council, Farnham, Surrey.
G1890 Sept. 13 TA1902 Sept. 6 TAM1909 Mar. 27 T1911 July 29	*CATCHPOLE, J. H.	Deputy Engineer and Surveyor, Finchley, N.
1912 Oct. 26	CATTANACH, D.	County Road Surveyor, Tobermory, Argylshire.
1895 Mar. 16 R1899 Feb. 25	CATT, A. J.	"Laurel Dene," Kingston-by-Sea, near Brighton.
G1904 May 29 TA1907 May 25 TAM1908 May 23 T1911 July 29	*CATTLIN, O., A. M. Inst. C.E.	Assistant Borough Engineer, Holborn.
1896 Mar. 21	CHADWICK, J...	Surveyor to the Urban District Council, Fenny Stratford.
1903 Jan. 17	CHAMBERS, S. H.	Surveyor to the Urban District Council, Hampton.
1901 Dec. 7	CHANCELLOR, W. B.	City Surveyor, Lichfield.
1897 Jan. 16	CHAPMAN, C. R. W.	Surveyor to the Urban District Council, Wembley.
1910 Apr. 23	CHAPMAN, H. T.	County Surveyor, Somerset. Wells. *Chairman*, South-Western District.
1912 Apl. 27	CHAPMAN, W. A.	County Road Surveyor, Lanarkshire County Council. Airdrie.
1893 Mar. 4 R1899 May 6	CHARLES, T.	The "Laurels," 26 Gayton Road, Harrow-on-the-Hill.
AM1907 Sept. 7 T1911 July 29	*CHART, R.	Chief Assistant Surveyor, Rural District Council, Croydon.
1884 Dec. 20	CHART, R. M.	Surveyor to the Rural District Council, Croydon. Town Hall, Croydon.
1909 Oct. 30	CHESNEY, S.	Surveyor to the Urban District Council, Featherstone, Yorks.
1912 Apl. 27	CHIVERS, H. J.	Surveyor to the Urban District Council, Fleet.
1900 Feb. 10	CHOWINS, W. H.	Surveyor to the Urban District Council, Burnham, Somerset.
AM1909 July 17 T1911 July 29	CHRISTIE, A. K.	City Road Surveyor's Office, Edinburgh.
1912 Sept. 9	CHURCHILL, A. F.	First Assistant to Director of Public Works, Hong Kong.
1911 July 5	CHURCHWARD, S. F. C.	Surveyor and Water Engineer, Urban Dist. Council, Dawlish.
1884 Oct. 9 R1907 June 20	CLARE, J., A.M. Inst. C.E. ..	Surveyor, Sleaford.
AM1909 Feb. 27 T1911 July 29	CLARE, S. F.	Surveyor, Urban District Council, Sleaford.
A1908 Feb. 29 TAM1910 Jan. 22 T1911 July 29	*CLARE, T. A.	Deputy Borough Surveyor, Leigh, Lancs.

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Date of Election and Transfer.			
1908 Jan. 18		CLARK, W. G. J.	Surveyor to the Urban District Council, Wigston Magna, Leicester.
1898 Sept. 3		CLARKE, E. O'N.	County Surveyor, Leitrim.
A1902 May 10 T1904 Apr. 30		CLARKE, G. E., A.M.Inst.C.E.	Borough Surveyor, Boston, Lincolnshire.
1899 Oct. 21		CLARKE, H. A.	Surveyor to the Urban District Council, Briton Ferry. *Hon. Secretary*, South Wales District.
1898 Oct. 15		CLARRY, W. A. H., A.M.Inst. C.E.	Borough Surveyor, Sutton Coldfield.
1886 Dec. 18		CLARSON, H. J.	Surveyor to the Rural District Council, Tamworth.
G1894 July 7 TA1904 Sept. 17 TAM1911 July 29 T1912 Feb. 10		*CLAYPOOLE, A. H., A.M.Inst. C.E.	Divisional Engineer, City Engineer's Department, Bristol.
1901 May 11		CLAYTON, F T.	Borough Engineer, Reigate.
G1894 July 7 T1908 Oct. 24		*CLEGG, H., A.M. Inst. C.E. ..	Surveyor to the Urban District Council, Felixstowe.
AM1909 Feb. 27 T1911 July 29		CLEGG, W. A.	Surveyor, Urban District Council, Dorking.
G1898 Dec. 17 TA1902 Mar. 22 TAM1908 Apr. 25 T1911 July 29		*CLEWS, C. A.	Deputy Borough Surveyor, Derby.
1893 July 31		CLOUGH, W.	Surveyor to the Urban District Council, Audenshaw.
1899 Oct. 21		CLUCAS, R. H.	Borough Surveyor, Kingston-on-Thames.
G1894 July 7 T1896 Oct. 24		*COALES, H. F., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sunbury-on-Thames.
G1886 Oct. 16 T1888 July 12		*COALES, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
1882 Sept. 30		COCKRILL, J. W., M. Inst. C.E. (*Vice-President.*)	Borough Surveyor, Great Yarmouth.
1893 June 24		COCKRILL, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Biggleswade, Beds.
1904 June 26		COLEBY, H. J.	Surveyor to the Rural District Council, Atherstone, Warwickshire.
1892 Sept. 24		COLLEN, W., M.A., M.Inst.C.E.	County Surveyor, Dublin.
G1899 June 29 TA1902 Jan. 25 TAM1907 Dec. 14 T1909 Apr. 24		*COLLINGE, T. P., A.M. Inst. C.E.	*Chairman*, Irish District. Borough Engineer and Surveyor, Mansfield.
1888 May 12		COLLINS, A. E., M.Inst.C.E. (*Past President. Member of Council.*)	City Engineer, Norwich.
A1905 May 27 TAM1907 Sept. 7 T1911 July 29		COLLINS, H., A. M. Inst. C.E.	Deputy City Engineer, Norwich.
1896 Jan. 18		COLLINS, R.	Surveyor to the Urban District Council, Enfield, N.
1905 Apr. 29		COLLINS, W. A.	Surveyor to the Rural District Council, Bridgwater.

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Date of Election and Transfer.			
G1897 Feb. 13 TA1901 Oct. 19 TAM1908 Apr. 25 T1911 July 29		*Collis-Adamson, A. C. ..	Assistant Borough Engineer, Hornsey, N. Municipal Offices, Highgate.
G1897 July 31 T1900 Dec. 15		*Cook, F. C., A.M. Inst. C.E.	Borough Surveyor, Nuneaton.
1893 Apr. 22		Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
G1888 July 12 T1890 Mar. 29		*Cook, J., Assoc. M. Inst. C.E.	Engineer to Fylde Water Board, Blackpool.
A1903 May 16 TAM1911 July 29 T1912 Feb. 10		Cooke, J. E..	Assistant Borough Engineer, Town Hall, Islington, N.
1898 Sept. 3		Cooper, E. C.	Surveyor to the Urban District Council, Shanklin, Isle of Wight.
1894 Oct. 20		Cooper, F. A., C.M.G., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
1887 Sept. 17		Cooper, W. W.	Surveyor to the Urban District Council, Slough.
1893 Apr. 22 R1902 Nov. 8		Copley, C. T., A.M.Inst.C.E.	252 Barkerhouse Road, Nelson, Lancashire.
1896 Jan. 18		Cordon, R. C.	Surveyor to the Rural District Council, Belper. "Belmont," Duffield, near Derby.
G1896 May 29 T1897 June 19		*Corrie, H. W.	Surveyor to the Urban District Council, Lower Bebington, Cheshire.
1894 June 21 R1903 Jan. 17		Cotterell, A. P. I., M. Inst. C.E.	28 Baldwin Street, Bristol; and 26 Victoria Street, S.W.
1906 Mar. 3		Cottle, F.	Borough Engineer, Douglas, Isle of Man.
AM1910 July 16 T1911 July 29		Coupe, A. E.	Surveyor to the Urban District Council, Fulwood, Lancs.
A1907 Sept. 7 TAM1911 July 29 T1912 Mar. 2		Court, W. H. A., A.M.Inst. C.E.	Borough Surveyor's Office, Leicester.
G1899 Oct. 21 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10		*Cowan, G.	District Surveyor, Town Hall, Portsmouth.
A1905 Mar. 4 T1911 Jan. 21		*Cox, C. L., A.M.Inst.C.E. ..	City Sanitation Engr., Colombo, Ceylon.
P1880 Feb. 7 R1911 Apr. 29		Cox, J. H., M. Inst. C.E. ..	Surveyor, Bradford.
AM1910 Mar. 12 T1911 July 29		Cozens, L. A.	Surveyor of Highways, Isle of Wight Rural District Council. "Walmer Villa," Castle Road, Newport.
G1906 Jan. 20 A1907 Mar. 2 T1911 Jan. 21		*Crabb, H. R., A.M.Inst.C.E.	Borough Surveyor, Municipal Offices, Pembroke Dock.
1900 Mar. 10		Crabtree, W. R., M.Sc.(Vict.), A. M. Inst. C.E.	Surveyor to the Rural District Council, Doncaster.
1911 June 10		Crawshaw, J. S.	Surveyor to the Urban District Council, Weybridge.

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Date of Election and Transfer.		
P1881 May 6	CREER, A., Assoc. M. Inst.C.E.	Engineer to Ouse and Foss Navigations. Yewhurst, Bickley, Kent.
A1902 Jan. 25 TAM1907 Dec. 14 T1911 July 29	CROOKE, W. E. FROOME ..	Chief Engineering Assistant, Middlesex County Council. 19 West Park Road, Kew Gardens.
AM1908 Oct. 24 T1911 July 29	CROOME, R.	Surveyor, Urban District Council, Cromer.
G1905 June 22 A1906 Nov. 3 TAM1910 Jan. 22 T1911 July 29	*CROSS, W. G., A.M. Inst. C.E.	Assistant Borough Engineer, Tunbridge Wells.
1889 Dec. 14	*CROWTHER, J. A., Assoc. M. Inst. C.E.	Borough Engineer, Southampton.
A1901 Oct. 19 T1910 Oct. 29	*CROXFORD, C. H.	Engineer and Surveyor, Urban District Council, Wood Green.
G1907 May 25 T1908 July 18	*CROXFORD, J. W...	Surveyor to the Urban District Council, Brentford.
G1900 Jan. 19 T1903 May 16	*CRUMP, E. H., A. M. Inst. C.E.	Surveyor to the Urban District Council, Hinckley.
G1898 June 30 T1904 Apr. 30	*CUDBIRD, T. O.	Shire Engineer, Amaroo, Cumnock, N.S.W.
AM1907 Dec. 14 T1911 July 29	CULLIN, H. B.	Surveyor to the Rural District Council, Isle of Wight.
1889 Dec. 14	CURRALL, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
1896 Apr. 25	CURRY, W. F.	P.W.D., Middelburg, Transvaal, S.A.
1893 Mar. 4 R1899 Feb. 25	CURRY, W. T., A. M. Inst.C.E.	Minas de Rio Tinto, Provincia de Huelva, Spain.
1897 Feb. 13	CUTLER, H. A., M. Inst. C.E. (*Vice-President, Ireland. Member of Council.*)	City Surveyor, Belfast.
1893 June 24	*DALTON, J. P.	Surveyor to the Urban District Council, Ryton-on-Tyne.
G1905 Jan. 28 TAM1909 Mar. 27 T1911 July 29	*DARBY, A. E., A.M. Inst. C.E.	Borough Engineer and Surveyor, Town Hall, Bethnal Green, N.E.
1912 Jan. 13	DASHPER, L. G.	Surveyor to the Urban District Council, Sandown Isle of Wight.
1899 Jan. 21	DAVIDSON, J. F.	P.O. Nairobi, British East Africa.
1900 Oct. 15	DAVIES, W. J.	Surveyor to the Urban District Council, Nantyglo and Blaina. Council Offices, Blaina.
1880 Apr. 10	DAVIS, A. T., M. Inst. C.E. (*Past President.*)	County Surveyor, Salop. Shrewsbury. *Chairman*, West Midland District.
AM1911 July 5 T1911 July 29	DAVSON, S. S.	Assistant Engineer, The Municipality, Alexandria, Egypt.
1900 Oct. 15	*DAWSON, C. F.	Surveyor to the Urban District Council, Barking.

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Date of Election and Transfer.		
1884 Apr. 19 R1902 Nov. 8	DAWSON, C. J.	Wykeham House, Barking.
1896 July 25	DAWSON, N. H.	Borough Surveyor, Banbury.
1898 Jan. 15	DAY, C.	Borough Surveyor, Chatham.
1898 Jan. 15	DEANE, J. W...	Surveyor to the Urban District Council, Smallthorne.
1892 Mar. 11	*DEARDEN, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
1904 July 14	DELANY, J. F.	City Engineer, Cork.
P1890 Feb. 1	DENNIS, N. F., M. Inst. C.E.	Borough Engineer, West Hartlepool.
AM1908 July 18 T1911 July 29	DENTON, A. J.	Borough Surveyor's Office, South Shields.
1896 July 25	DEWHIRST, J...	Surveyor to the Rural District Council, Chelmsford.
G1898 Oct. 15 T1899 June 10	*DICKINSON, A. J.	Surveyor to the Urban District Council, Redditch.
1895 June 27	DICKINSON, R.	Surveyor to the Urban District Council, Berwick-on-Tweed.
1881 Dec. 10	DIGGLE, J., A.M. Inst. C.E.	Water Engineer, Heywood.
1910 Jan. 22	DIGGLE, J. S., A. M. Inst. C.E.	Water Engineer, "Oakhurst," Heywood.
1897 Apr. 10	DIVER, D. J.	Surveyor to the Urban District Council, Marple, near Stockport.
1897 Jan. 16 R1903 Jan. 17	DIXON, F. J., A.M. Inst. C.E.	Town Hall Chambers, Ashton-under-Lyne.
G1891 Aug. 1 T1896 Oct. 24	*DIXON, J. R. M. Inst. C.E.	Borough Engineer, Town Hall, Woolwich.
1887 June 18	DIXON, R.	Borough Surveyor, Stratford-on-Avon.
1912 Jan. 13	DIXON, W.	Engineering Assistant, Municipal Buildings, Leeds.
1889 July 4	DODD, P., M. Inst. C.E. ..	Borough Engineer, Wandsworth. 215 Balham High Road, S.W.
1897 Jan. 16	*DODGEON, A., A.M. Inst. C.E.	Surveyor to the Urban District Council, Clayton-le-Moors.
G1891 Sept. 12 TA1902 Sept. 6 TAM1907 Dec. 14 T1911 July 29	*DOLAMORE, F. P.	Deputy Borough Engineer, Bournemouth.
1909 Sept. 4	DONALD, D. A.	Burgh Surveyor, Grangemouth.
1888 May 12	DORMAN, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh. *District Representative*, Irish District.
1898 June 30	DORMER, P. C.	Surveyor to the Urban District Council, Chesham, Bucks.
G1903 June 25 T1904 Sept. 17	*DOUGLAS, S.	Surveyor to the Urban District Council, Kenilworth.
1906 Jan. 20	DOUGLASS, W. L., M.Inst.C.E.	District Engineer, Middle Ward, Lanark County. District Offices, Hamilton.
1912 July 11	DRAKE, S. R.	Engineer and Surveyor to the Urban District Council, Leatherhead.

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Date of Election and Transfer.		
G1904 May 28 TA1908 Sept. 5 TAM1911 July 29 T1912 Feb. 10	*Draper, J., A.M.Inst.C.E. ..	Surveyor to the Urban District Council, Council Offices, Saltburn-by-the-Sea.
A1906 June 28 TAM1909 June 5 T1911 July 29	*Dresden, W. J.	Engineer's Office, Town Hall, Battersea.
A1909 Feb. 27 T1910 Oct. 29	Drew, J. H.	Engineer and Surveyor, Urban District Council, Wath-upon-Dearne.
1899 Oct. 21	Dryland, A., M.Inst. C.E. ..	County Surveyor, Surrey. Kingston-on-Thames. *Chairman*, South-Eastern District.
1891 Dec. 12	Duffin, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.
1900 Dec. 15 R1901 June 8	Dunch, T. H.	27 Clement's Lane, Lombard Street, E.C.
1898 May 21	Dunn, J...	Surveyor to the Rural District Council, Chesterton. Brunswick House, Cambridge.
A1907 Jan. 19 TAM1910 July 16 T1911 July 29	*Dunning, W. J.	Assistant Surveyor, Colwyn Bay.
1873 Feb. 15	Dunscombe, C., M.A., M. Inst. C.E.	92 Victoria Street, Westminster, S.W.
G1891 Jan. 21 T1892 Sept. 24	*Dyack, W., M. Inst. C.E. ..	Burgh Surveyor, Aberdeen.
G1899 June 29 TA1905 June 22 TAM1909 June 5 T1911 July 29	*Dyer, R. H.	Deputy Borough Engineer, Southend.
1882 June 29	Dyer, S...	Engineer to the Rural District Council, Bridlington, 29 Quay Road, Bridlington.
1879 May 1	Earnshaw, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
1904 Aug. 3 R1909 Oct. 30	Easton, W. C., B. Sc., M. Inst. C.E.	14 Blythswood Square, Glasgow.
1883 Aug. 4	Eaton-Shore, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
1890 Feb. 1	Eddowes, W. C.	Borough Surveyor, Shrewsbury.
1910 June 16	Edwards, D., A.M.Inst.C.E.	Borough Engineer, Taunton.
G1907 Sept. 7 TAM1911 July 29 T1912 Feb. 10	*Edwards, E. W.	Surveyor to the Urban District Council, Blaenavon, Mon.
1911 Dec. 2	Edwards, E. Watkin	Engineer and Surveyor to the Urban District Council, Mynyddislwyn, Council Offices, Pontllanfraith, Mon.
1904 Jan. 23	Edwards, H. C. J., Assoc. M. Inst. C.E.	Borough Engineer, Lambeth.
G1906 Dec. 15 TAM1909 Mar. 27 T1911 July 29	*Edwards, J. H.	Chief Assistant, Engineer's Office, Rural District Council, Wrexham.

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Date of Election and Transfer.			
1907 Nov. 2	Elce, W. H., A. M. Inst. C.E.	Borough Engineer, Bacup.
1911 Jan. 21	*Eley, W. H.	Engineer and Surveyor, Urban District Council, Town Hall, Newmarket.
1897 July 31	*Elford, E. J.	Borough Surveyor, Southend-on-Sea. *Hon. Sec.*, Eastern District.
1873 Feb. 15	ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	13 Charles Street, St. James's, London, S.W.
G1898 Dec. 17 TA1901 Dec. 7 TAM1911 July 29 T1912 Feb. 10	*Ellison, D., A.M.Inst.C.E. ..	Deputy Borough Engineer, West Bromwich.
G1898 Feb. 19 TA1902 Jan. 25 TAM1911 July 29 T1912 Feb. 10	*Endsor, H. A.	Surveyor to the Rural District Council, Keynsham, Bristol.
1907 May 25	England, J.	Borough Engineer, Wrexham. *Hon. Sec.*, North Wales District.
1895 July 27	Entwisle, H.	Surveyor to the Urban District Council, Swinton, near Manchester.
G1898 Dec. 17 TAM1909 Dec. 11 TP1911 Jan. 21	*Essex, E. H., A.M.Inst.C.E.	Engineer and Surveyor, Urban District Council, Leyton, Essex
1897 Jan. 16	Evans, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
1895 Jan. 19	Evans, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, S. Wales.
1896 May 29	Evans, J. P. .. .. (*Member of Council.*)	Surveyor to the Rural District Council, Wrexham. *District Representative*, North Wales District.
1903 Oct. 17	Evans, S.	County Surveyor, Mold, Flintshire.
1890 June 7	Fairley, W., M. Inst. C.E.	Richmond Main Sewerage Board, Kew Gardens, S.W., and Parliament Mansions, Victoria Street, S.W.
AM1908 Dec. 5 T1910 Dec. 10	Farmer, H. J.	Borough Surveyor, Christchurch, Hants.
1893 July 31	Farrington, T. B., A. M. Inst. C.E.	Surveyor to the Rural District Council, Conway. Trinity Square, Llandudno.
1896 Jan. 18	Farrington, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Woodford Green, Essex.
1900 Dec. 15	*Fellows, T. E.	Surveyor to the Urban District Council, Willenhall.
1894 Jan. 18	Fenn, T...	Surveyor to the Urban District Council, Belper.
AM1909 Dec. 11 T1911 July 29	Fenton, H.	Surveyor to the Urban District Council, Thornton, Lancs.
1887 Sept. 17 B1899 June 10	Fiddian, W.	Engineer to Stourbridge and Stour Valley Sewerage Boards. Old Bank Offices, Stourbridge.
P1899 Jan. 21	Fidler, A., M. Inst. C.E. ..	Borough Engineer, Northampton. *Chairman*, Eastern District.
G1891 June 25 T1906 Sept. 22	*Finch, A. R., A. M. Inst. C.E.	Borough Surveyor, Kensington.

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Date of Election and Transfer.		
G1898 June 30 T1904 Jan. 23	*Finch, E. E., A.M.Inst.C.E.	Public Health Department, Engineer's Office, Guildhall, E.C.
1904 Nov. 18	Findlay, J. R.	Burgh Surveyor, Leith.
1894 Jan. 13	Findlay, R., A.M.Inst.C.E.	Surveyor, Eltham Green, S.E.
G1892 May 28 T1897 Jan. 16 R1903 July 25	*Fitton, G.	8 John Dalton Street, Manchester.
1903 May 16	Fitzmaurice, Sir M., C.M.G., M.Inst.C.E.	Chief Engineer, London County Council, Spring Gardens.
1906 Sept. 22	Forbes, A.	County Road Surveyor, Fife C.C. Queen Anne Street, Dunfermline.
G1895 July 27 T1899 Jan. 21	*Forbes, A. H.	Surveyor to the Urban District Council, Saffron Walden.
A 1904 Aug 27 TAM 1911 July 29 T 1912 June 1	Forbes, W.	First Engineering Assistant to Burgh Engineer, Edinburgh.
1896 Nov. 28	Ford, G...	City Surveyor, St. Albans.
G1903 Feb. 21 TA1908 Sept. 5 TAM1911 July 29 T1912 Feb. 10	*Foster, J. W.	Chief Assistant to City Engineer, Bradford.
G1903 June 6 TAM1908 Sept. 5 T1911 July 29	*Foster, W. A., A.M.Inst.C.E.	Richmond Chambers, Blackburn.
G1909 July 17 TAM1911 July 29 T1912 Apr. 27	*Fothergill, J. R.	Borough Engineer's Office, Bexhill-on-Sea.
G1901 June 8 TA1901 Oct. 19 T1907 Sept. 7	*Fowlds, W., A.M.Inst.C.E.	Borough Engineer, Keighley.
1873 May 2	FOWLER, ALFRED M., M.Inst.C.E. (*Past President.*)	1 St. Peter's Square, Manchester.
G1896 Jan. 18 TA1904 May 28 T1906 May 26	*Fox, S. F. L., Assoc.M.Inst. C.E.	Main Drainage Works, Cairo, Egypt.
1911 Apr. 29	*Frank, T., A.M.Inst.C.E...	Town Hall, Newark-on-Trent.
G1898 June 30 T1902 Nov. 8	*Fraser, R. W.	Surveyor to the Urban District Council, Hoylake, Cheshire.
1912 July 27	Freeman, A.	Surveyor to the Urban District Council, Rickmansworth.
P1895 Oct. 19	Frost, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
1887 June 18 R1898 Jan. 15	Fry, W. H., A.M.Inst.C.E.	9 High Street, Gosport.
G1901 May 11 TA1902 Jan. 25 TAM1911 July 29 T1912 Feb. 10	*Gair, J.	Assistant Borough Surveyor, Town Hall, Marylebone.
A1903 Mar. 21 PTAM1909 Jan. 23 T1909 Mar. 27	Galbraith, A. R., M.Inst. C.E.I.	Director of Public Works, Zanzibar Protectorate, East Africa.
1885 June 6	Gammage, J.	Borough Surveyor, Dudley.
1891 Dec. 12 R1899 June 10	Garratt, C. T.	Estate Office, Newtown Linford, Leicestershire.
1910 Mar. 12	Garrett, H. A., A.M.Inst. C.E.	Borough Surveyor, Torquay.

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Date of Election and Transfer.		
1886 Mar. 13 A1902 Feb. 22	GASKELL, P.	Albert Chambers, Carr Lane, Hull.
1902 Jan. 25 B1909 Apr. 23	GENT, T. W. B.	District Surveyor, Salford Hundred. 24 Clarendon Crescent, Eccles, near Manchester.
1902 Feb. 22	GEORGE-POWELL, J.	County Surveyor, Wiltshire, Trowbridge.
1905 Jan. 28	GETTINGS, C. F.	County Surveyor, Shire Hall, Worcester.
G1903 June 25 T1909 July 17	*GETTINGS, S. S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Tring.
AM1911 Mar. 4 T1911 July 29	*GIBBINS, F. R., B.Sc. (Lond.), A. M. Inst. C.E.	Town Hall, Manchester.
1901 Oct. 19	GIBBS, A. G.	Surveyor to the Rural District Council, Midhurst, Sussex.
1900 Mar. 10	GIBSON, S.	Surveyor to the Urban District Council, Biddulph.
1910 Apr. 23	GIBSON, W. L.	County Engineer, Western Division, Perthshire. Dunblane.
1899 June 10	GLADWELL, A.	Engineer and Surveyor, Rural District Council, Eton. 160 High Street, Slough, Bucks.
1904 Jan. 23	GLEDHILL, G.	Surveyor to the Urban District Council, Balby with Hexthorpe.
1893 May 13	*GLOYNE, R.M., M. Inst. C.E.	District Engineer, Spring Gardens, S.W.
G1898 Jan. 15 A1903 Jan. 17 AM1907 Nov. 2 T1910 Jan. 22	*GODFREY, C. H., A.M. Inst. C.E.	Engineer and Surveyor, Municipal Council. Shanghai (*via* Siberia).
1895 Jan. 19	GOLDER, T. C.	Borough Surveyor, Deal.
AM1912 Jan. 13 T1912 July 11	GOLDSMITH, H. E.	Chief Assistant to Municipal Engineer, P.W.D., Hong Kong.
1911 Mar. 4	*GOODE, W. J.	Surveyor, Rural District Council, Clutton, near Bristol. Temple Cloud, Bristol.
AM1907 Sept. 7 T1911 July 29	GOODWIN, J. D.	Borough Engineer, Ashfield, N.S.W.
1911 Jan. 21	*GOODWIN, W. J., A.M.Inst.C.E.	City Engineer, Salisbury.
1886 June 12	GOODYEAR, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
A1907 Apr. 27 TAM1908 Feb. 29 T1911 July 29	*GOOSEMAN, A. T.	Deputy Borough Engineer, Bootle.
1897 June 19	GORDON, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
G1894 Jan. 13 TA1902 July 10 TAM1911 July 29 T1912 Feb. 10	*GORDON, J., A.M.Inst.C.E.	Assistant Burgh Surveyor, Aberdeen.
AM1908 June 25 T1911 July 29	GORDON, T. W.	Assistant City Engineer, Nottingham.
1912 July 11	GORMAN, J.	State Engineer to Govt. of Kedah, Malay States.
1899 June 10	GOUDIE, A. H.	Burgh Engineer, Stirling.
1911 July 5	GRANT, A. L...	Surveyor, Rural District Council. 15 High Street, High Wycombe.

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Date of Election and Transfer.			
G1897 June 19 T1901 Dec. 7	*Grant, F. T.	Borough Surveyor, Gravesend.
1905 Sept. 23	Gray, C. C.	Surveyor to the Urban District Council, Scunthorpe, Lincs.
G1887 Feb. 5 PT1893 Apr. 22	*Greatorex, A. D., M. Inst. C.E. (*Past President. Member of Council.*)	Borough Surveyor, West Bromwich.
1899 June 10	Green, G., M. Inst. C.E. ..	Borough Engineer, Wolverhampton.
1901 Feb. 16	Green, J. S.	Borough Engineer, Haslingden.
1897 Mar. 13	Green, W.	Surveyor to the Urban District Council, Castleford.
A1901 Dec. 7 T1903 Dec. 12	Greenshields, N., Assoc. M. Inst. C.E.	Borough Engineer, Bedford.
1890 May 3 B1898 Apr. 23 G1893 Jan. 14	Greenwell, A., Assoc. M. Inst. C.E	30 Furnival Street, Holborn, E.C.
TA1901 Oct. 19 TAM1908 Sept. 5 T1911 July 29	*Greenwood, J. P., A.M.Inst. C.E.	Deputy Borough Surveyor, Burnley.
1898 Mar. 19	Gregory, T.	Surveyor to the Urban District Council, Newburn-on-Tyne.
1892 Jan. 16	Gregson, G.	Surveyor to the Rural District Council, Durham.
1886 Oct. 16	Gregson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
1882 Sept. 30	Grieves, R.	Surveyor to the Urban District Council, Blyth, Northumberland.
1897 June 19	Grieves, W. H.	Surveyor to the Urban District Council, Sutton, Surrey.
1904 Oct. 29	*Griffiths, H. Ll.	Borough Surveyor, Brecon.
1908 June 25	Grimwood, G. F.	Borough Engineer, Monmouth.
AM1911 Mar. 4 T1911 July 29	Grove, F.	Assistant County Surveyor, Surrey. County Hall, Kingston.
1912 Sept. 9	Groves, E. D.	Surveyor and Waterworks Engineer, St. Austell.
1898 Dec. 17	Guilbert, T. J.	States Surveyor, Guernsey.
1909 Mar. 27	Gullan, H. F., M. Inst. C.E.	Superintendent of Works, City Hall, Belfast.
1912 July 11	Gurney, R. G.	Surveyor to the Urban District Council, Ledbury, Hereford.
G1905 June 22 T1911 July 5	*Hadfield, J. R.	Town Surveyor, Urban District Council, Uttoxeter.
A1902 Mar. 22 TAM1907 Dec. 14 T1909 Sept. 4	Hadfield, W. J.	Surveyor of Highways, Town Hall, Sheffield.
1897 June 19	Hague, S.	Borough Surveyor, Dukinfield.
G1897 June 19 TA1901 Oct. 19 TAM1908 June 25 T1911 July 29	*Haigh, W. H., A.M.Inst.C.E.	Chief Assistant City Engineer, Cardiff.
1906 June 28	*Hailstone, T. H.	Surveyor to the Urban District Council, Birstall, near Leeds.
1896 Apr. 25	Hainsworth, M.	Surveyor to the Urban District Council, Teddington.

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Date of Election and Transfer.		
1902 Sept. 6	HALE, A., M. Inst. C.E.I. ..	Municipal Engineer, Howrah, Bengal.
G1899 Dec. 16 T1901 Oct. 19	*HALL, C.	Surveyor to the Urban District Council, Droylsden, near Manchester.
1902 Nov. 8	HALL, E.	Borough Surveyor, Carnarvon.
1912 July 11	HALL, H. L.	Deputy Engineer, Borough Engineer's Office, Batley.
1884 Apr. 19 B1903 Mar. 21	HALL, J., M. Inst. C.E.	28 Esplanade Road, Bombay. *Hon. Sec.*, Indian District.
1900 June 16	HALLAM, R.	Surveyor to the Rural District Council, Eton.
1901 May 11	HALLER, J. C.	Surveyor to the Urban District Council, Carlton, near Nottingham.
1905 June 22	*HALSTEAD, B.	Surveyor to the Urban District Council, Brierfield, Lancs.
G1909 June 5 T1910 Sept. 17	*HAMBY, C. L.	Borough Surveyor, Beccles.
1887 Mar. 12	HAMBY, G. H., A.M.Inst.C.E.	Borough Engineer, Lowestoft.
1904 Mar. 26	HAMMOND, H.	County Engineer, Hobson C.C. Council Chambers, Dargaville, Auckland, N.Z.
1897 Feb. 13	HAMP, H. J., Assoc. M. Inst. C.E.	Borough Surveyor, Swindon.
1896 Jan. 18	HARA, R.	32 Nichomi, Ichigatachima, Tokio, Japan.
1899 June 29	*HARGREAVES, J. E.	Surveyor to the Urban District Council, Farnborough, Hants.
G1901 June 27 TAM1909 Dec. 11 T1911 July 29	*HARLOW, W. W. R., A.M.Inst. C.E.	Deputy City Engineer, Carlisle.
1899 May 6	HARMAN, E. A., M. Inst. C.E.	Corporation Gas Engineer, Huddersfield.
1897 Mar. 13	HARPUR, A. O.	Surveyor to the Urban District Council, Caerphilly.
1905 Jan. 28	HARPUR, J. L.	Town Surveyor, Brierley Hill.
A1907 Mar. 2 TAM1907 Dec. 14 T1911 Apr. 29	HARPUR, S. J.	Engineer and Surveyor to the Urban District Council, Maesteg.
1894 Mar. 3	HARPUR, W., M. Inst. C.E. (*Past President. Member of Council.*)	City Engineer, Cardiff. *Chairman*, South Wales District.
1910 Dec. 10	HARPUR, W. L.	County Roads Surveyor, Breconshire County Council.
1896 Jan. 18	HARRIS, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough, Tunbridge Wells.
1911 Oct. 21	HARRIS, F. J.	Surveyor to the Rural District Council, Holsworthy. Uplands Terrace, Holsworthy, North Devon.
1911 Dec. 2	HARRIS, J. P.	Resident Engineer, L.C.C. Main Drainage Works. 86 Thurlow Park Road, Dulwich.
AM1908 Dec. 5 T1911 July 29	HARRIS, J. W.	Surveyor, Rural District Council, Wantage.

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Date of Election and Transfer.		
1901 May 11	HARRISON, A., M.Inst.C.E. ..	Borough Engineer, Southwark. Town Hall, Walworth Road, S.E.
1906 Apr. 28	*HARRISON, E. Y., Assoc. M. Inst. C.E.	Surveyor and Water Engineer to the Urban District Council, Wellingborough.
1899 June 29	HARRISON, G. F. P.	Surveyor to the Rural District Council, East Stow. Stowmarket, Suffolk.
G1900 Mar. 19 T1905 Mar. 3	*HARRISON, J. W.	Surveyor to the Rural District Council, Uxbridge.
G1903 June 25 T1908 Oct. 24	*HARRISON, P. T., A.M. Inst. C.E.	Borough Surveyor, Chelmsford.
AM1910 Mar. 12 T1911 July 29	HARRISON, P. W.	Henford House, Yeovil, Somerset.
G1907 Nov. 2 TAM1910 June 16 T1911 July 29	*HARRISON, W. A.	Chief Assistant, Council Offices, Long Eaton, Derbyshire.
1912 Mar. 2	HARROP, T.	Surveyor to the Urban District Council, Bispham with Norbreck. 23 Warbreck Drive, Blackpool.
1905 Sept. 28	HART, G. A.	Sewerage Engineer, Municipal Buildings, Leeds.
1909 June 5	*HARTFREE, G. B.	Surveyor to the Urban District Council, Alton.
1896 Oct. 24	HARTLEY, T. H.	Borough Surveyor, Colne.
1912 July 27	HARVEY, F. C.	Assistant Surveyor to the Urban District Council, Gosport and Alverstoke.
1911 Oct. 21	HARVEY, H. S.	Borough Surveyor, Evesham.
1893 Oct. 21	HARVEY, T. F., M. Inst. C.E.	Waterworks Engineer, Merthyr Tydvil Corporation.
1907 Apr. 27	HAWKE, W. C., A. M. Inst. C.E.	Borough Surveyor, Dover.
1889 Feb. 9	HAWKINS, I. T., Assoc. M. Inst. C.E.	Chief Engineer and Director General, San Pedro, French Ivory Coast, West Africa.
1906 Dec. 15	HAWKINS, J. F.	County Surv., Roads & Bridges, Berkshire. Reading.
1892 Apr. 23	HAWLEY, G. W.	Highway Surveyor, Rural D.C., Basford. Burton Buildings, Parliament St., Nottingham.
1902 July 10	HAYNES, H. T. Assoc. M.Inst. C.E.	Town Hall, Fremantle, West Australia.
G1897 June 19 T1898 Jan. 15	*HAYWARD, T. W. A., M.Inst. C.E. (*Vice-President.*)	Borough Surveyor, Town Hall, Battersea.
G1899 Jan. 12 T1903 June 25	*HAYWOOD, S. S.	Borough Engineer, Brighouse.
1907 Mar. 2	HEAP, J. A.	Borough Surveyor, Todmorden.
1899 June 10	HEATH, J.	Surveyor to the Urban District Council, Urmston.
G1903 Jan. 17 A1905 Apr 29 TAM1910 Mar. 12 T1911 July 29 R1912 Jan. 13	*HEATH, J. R.	Deputy Borough Surveyor, Stoke-on-Trent.
1912 June 1	HEATHER, F.	Surveyor to the R.D.C., South Stoneham, Hants.
1909 Dec. 11	HECKFORD, H., M. Inst. C.E.	Borough Surveyor, Poplar, E.

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Date of Election and Transfer.		
G1908 Feb. 29 T1910 Dec. 10	*Hedges, H. N.	Surveyor, Rural District Council, Berkhampstead. 55 Western Road, Tring.
G1893 Jan. 14 T1910 Mar. 12	*Hellawell, O.	District Surveyor, Withington, Manchester.
1911 Oct. 21	Henderson, A. F.	Municipal Engineer, Chittagong, Eastern Bengal.
1890 Feb. 1 R1908 Jan. 18	Henderson, A. J., Assoc. M. Inst. C.E.	c/o Post Office Box 117, North Vancouver, British Columbia.
1897 Feb. 13	Henry, T.	Surveyor to the Rural District Council, East Retford.
1903 Dec. 12	Henshaw, R. S.	Surveyor to the Urban District Council, Portland.
1892 June 11	Heron, J., B.E., B.A.	County Surveyor, Co. Down. Courthouse, Downpatrick. Ireland.
1902 May 10	Heslop, R.	Surveyor to the Urban District Council, Tanfield, co. Durham
G1906 June 28 TAM1911 July 29 T1912 Feb. 10	*Hewes, G. W.	Surveyor to the Urban District Council, Barrowford.
G1905 Dec. 9 TA1906 Dec. 15 T1909 Jan. 23	*Hewitt, F.	Surveyor to the Rural District Council, Kiveton Park, near Sheffield.
AM1908 July 18 T1911 July 29	Hicks, W. R., A. M. Inst. C.E.	Deputy Borough Engineer, Ealing, W.
1894 July 7	Higgens, T. W. E., Assoc. M. Inst. C.E.	Borough Surveyor, Town Hall, Chelsea, S.W.
1898 May 21	Higgins, J.	Chief Engineer, Grey Co., New Zealand.
G1903 Oct. 17 T1906 Nov. 3	*Hill, H. F.	Surveyor to the Urban District Council, Ware.
AM1909 Dec. 11 T1911 July 29	Hill-Willis, S. A.	Surveyor to the Urban District Council, Tilbury.
G1900 Mar. 10 TA1902 May 10 TAM1911 July 29 T1912 Feb. 10	*Hinchsliff, E. R., A.M.Inst. C.E.	Deputy Surveyor, Council Offices, Barry.
AM1910 Mar. 12 T1911 July 29	*Hindle, L. M.	Assistant Surveyor, Urban District Council, Chadderton.
1902 July 10	*Hines, C. E.	Surveyor to the Urban District Council, Windermere.
A1905 Jan. 28 T1908 Dec. 5	Hipwood, J. W., A.M.Inst. C.E.	Borough Engineer, Morecambe.
1898 Sept. 3	Hirst, R. P., A.M. Inst. C.E.	Borough Surveyor, Southport.
1909 Dec. 11	*Hodgson, C. F.	Surveyor to the Urban District Council, Otley, Yorks.
1895 June 27	Hodgson, W.	Surveyor to the Urban District Council, Keswick.
1896 Apr. 25 R1901 May 11	*Hogbin, L. W.	"Rowena," Preston Road, Leytonstone, N.E.
G1900 Aug. 25 TA1902 Mar. 22 TAM1911 July 29 T1912 Feb. 10	*Holloway, W. C.	Engineer and Surveyor, Urban District Council, Waltham Cross.

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Date of Election and Transfer.		
P1904 Aug. 16	HOLMES, F. G.	Burgh Surveyor, Govan.
1892 Mar. 11	HOLMES, G. W., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Walthamstow, N.E.
1912 July 11	HOLMES, H.	Borough Surveyor, Ossett.
G1907 Dec. 14 TAM1909 Apr. 24 T1911 July 29	*HOLT, P., Assoc. M. Inst. C.E.	Assistant Borough Surveyor, Rawtenstall.
G1903 Dec. 12 T1904 Oct. 29	*HOLT, R. B.	Permanent Way Engineer, Sovereign St. Depôt, Leeds.
1901 Dec. 7	*HOLT, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
AM1910 Mar. 12 T1911 July 29	HONEY, R. L.	Deputy Borough Engineer, Chatham.
1884 Oct. 9	HOOLEY, E. P., M. Inst. C.E. (*Past-President. Member of Council.*)	County Surveyor, Nottingham *District Representative*, East Midland District.
1898 Jan. 15	HOPKINSON, F.	Surveyor to the Rural District Council, Blyth and Cuckney. 66 Bridge Street, Worksop.
1891 Dec. 12	HORAN, J., M.E., M. Inst. C.E.	County Surveyor, 82 George Street, Limerick, Ireland.
A1902 Feb. 22 T1906 Nov. 3	HORTON, J. W., Assoc. M. Inst. C.E.	County Surveyor, Derbyshire.
1911 Oct. 21	HOSKEN, A.	Borough Engineer, Smethwick.
AM1911 Mar. 4 T1911 July 29	*HOSKEN, W.	Chief Assistant Surveyor, Rural District Council, Hendon. Great Stanmore.
1894 Mar. 3	HOWARD, H.	Surveyor to the Urban District Council, Littlehampton.
1880 May 27	HOWCROFT, J.	Surveyor to the Urban District Council, Redcar, Yorkshire.
G1903 Jan. 17 T1909 Feb. 27	*HOWELLS, D. P., A.M. Inst. C.E.	Town Engineer, Benoni, Transvaal.
1896 Feb. 22	HOWSE, W. T.	Surveyor to the Urban District Council, Bexley.
1897 June 17	HUGHES, H. T.	Highway Surveyor, Hayfield Road, Chapel-en-le-Frith.
1899 June 1 B1912 Jan. 13	HUMPHRIES, H. H.	Holydene, Erdington, Birmingham.
1911 Mar. 4	HUNT, A. A.	County Surveyor, West Suffolk. Bury St. Edmunds.
1897 July 8	HUNTER, T.	Borough Engineer and Surveyor, Leigh.
G1901 Aug. 24 T1901 Dec. 7	*HUTTON, F.	Surveyor to the Urban District Council, Ashton-on-Mersey.
A1902 Feb. 22 TP1903 Mar. 21	HUTTON, S.	Surveyor to the Urban District Council, Exmouth.
1898 May 21 B1906 Mar. 3	INGAMELLS, E. W.	Surveyor, Pokesdown.
G1895 Apr. 20 T1896 Oct. 24	*INGHAM, W., M. Inst. C.E. ..	Chief Engineer, Rand Water Board, Johannesburg, Transvaal.

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Date of Election and Transfer.			
1912 Mar. 2	Inglis, H.		Burgh Engineer, Airdrie.
1899 Feb. 25	Ingram, S.		County Surveyor, Devon. Exeter.
1888 Nov. 17	Irving, W. E.		"Rochdale," Murarrie, Brisbane, Australia.
1912 July 27	Ives, L.		Deputy City Surveyor, Wakefield.
1904 May 28	Iveson, J. A.		Surveyor to the Rural District Council, 2 Nares Street, Scarborough.
1900 July 19	Jack, G. H.		County Surveyor, Herefordshire.
1893 Oct. 21 R1909 Mar. 27	Jaffrey, W.		Bridge Chambers, Matlock.
1896 Oct. 24	James, A. C., A.M. Inst. C.E.		Surveyor to the Urban District Council, Grays Thurrock. Grays.
1903 Dec. 12	James, C. C., M.Inst.C.E. ..		The Ministry, P.W.D., Cairo. 28 Victoria Street, S.W.
G1887 Oct. 22 T1890 Mar. 29	*Jameson, M. W., A. M.Inst. C.E.		Borough Engineer, Stepney. Gt. Alie St., Whitechapel, E.
1897 Feb. 13	Jarvis, R. W.		Surveyor to the Rural District Council, Tenbury.
1885 Apr. 18	Jeeves, E.		Surveyor to the Urban District Council, Melton Mowbray.
G1898 Jan. 15 T1903 Oct. 17	*Jeffes, R. H., A. M. Inst. C.E.		Surveyor to the Urban District Council, Malden.
G1896 Jan. 18 T1896 Oct. 24	*Jenkin, C. J., M. Inst.C.E. ..		Surveyor to the Urban District Council, Finchley, N.
1899 June 10	Jenkins, D. M., A.M.Inst.C.E.		Borough Surveyor, Neath.
G1897 July 21 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	*Jenkins, R. J.		Chief Assistant, Town Hall, Portsmouth.
AM1911 Mar. 4 T1911 July 29	*Jenkins, R. H.		Engineer Assistant to City Surveyor, Guildhall, York.
G1906 Dec. 15 TAM1911 July 29 T1912 Feb. 10	*Jenkinson, F. C.		Chief Assistant Engineer, Rural District Council, Imperial Buildings, Rotherham.
G1900 June 16 A1901 Oct. 19 AM1907 Nov. 2 T1908 May 23	*Jerram, G., A.M. Inst. C.E.		Surveyor to the Urban District Council, Merton.
1892 July 21	Jevons, J. H., A. M. Inst. C.E.		Borough Surveyor, Hertford.
1904 May 28	Johnson, J.		Borough Surveyor, Rawtenstall.
1895 June 27	Johnston, J., M. Inst. C.E.		Waterworks Engineer, Brighton.
G1897 June 19 TA1902 Jan. 25 TAM1907 Dec. 14 T1911 July 29	*Johnston, R. W.		Deputy Borough Engineer, Birkenhead.
1883 Aug. 4 R1902 Nov. 8	Jones, U.C., Lt.-Col. A. S., M. Inst. C.E.		Ridge Cottage, Finchampstead, Berks.

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Date of Election and Transfer.		
1873 Feb. 15	JONES, CHAS., M. Inst. C.E. *(Past President and Gen. Hon. Secretary. Member of Council.)*	Borough Surveyor, Ealing, Middlesex.
1894 July 7	JONES, CHRIS.	Borough Surveyor, Hythe, Kent.
G1907 Sep. 7 T1910 Mar. 12	*JONES, F. E.	Engineer and Surveyor to the Urban District Council, Tyldesley, Lancs.
G1908 May 16 T1904 June 26	*JONES, F. W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Frome, Somerset.
G1901 June 8 TA1904 Mar. 26 TAM1908 Feb. 29 T1911 July 29	*JONES, H. O.	Deputy Borough Engineer and Surveyor, Folkestone.
1874 Jan. 29	JONES, I. M., M. Inst. C.E. ..	Consulting Engineer, Chester.
1894 June 21	JONES, J. O.	Surveyor to the Rural District Council, Biggleswade.
1894 June 21	JONES, J. P.	Surveyor to the Rural District Council, Gellygaer, Hengoed, *viâ* Cardiff.
AM1909 Sept. 4 T1911 July 29	*JONES, M. R.	Surveyor to the Urban District Council, Abergele.
1903 June 6	JONES, R. R.	Council Offices, Milnrow, near Rochdale.
1900 Mar. 10	JONES, T. C.	Surveyor to the Urban District Council, Frimley, Camberley, Surrey.
1892 May 28	JONES, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Colwyn Bay. *Chairman*, North Wales District.
AM1911 Apr. 29 T1911 July 29	JONES, W.	Borough Surveyor, Thetford, Norfolk.
1908 Sept. 5	JONES, W. H. M.	City Surveyor, Chester.
1897 Feb. 13	JONES, W. J.	Surveyor to the Urban District Council, Rhondda.
1898 Apr. 23	JONES, W. P.	Surveyor to the Urban District Council, Glyncorrwg.
1891 June 25	JUKES, W. H.	Surveyor to the Urban District Council, Tipton.
G1895 Oct. 19 AM1907 Nov. 2 TP1908 June 25	*JULIAN, J., B.E.	Borough Surveyor, Cambridge.
1895 July 27 R1899 Dec. 16	KAY, W. R., A.M. Inst. C.E.	Surveyor General of Highways, Athol Street, Douglas, Isle of Man.
1892 Apr. 23	KENNEDY, J. D.	Borough Surveyor, East Retford.
1905 Jan. 28	*KENYON, L.	Surveyor to the Urban District Council, Tottington.
A1902 May 10 TAM1911 July 29 T1912 Mar. 2	KER, A. M., B.Sc. (Vict.), A.M.Inst.C.E.	Borough Engineer, Town Hall, Warrington.
1892 July 11	KIDD, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.

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Date of Election and Transfer.		
G1896 June 25 A1906 Dec. 15 TAM1910 Mar. 12 T1911 July 29	*Kieser, W. H. G., Assoc. M. Inst. S.E.	District Engineer, City Engineer's Office, Bristol.
1899 Oct. 21	Killick, J. S., A.M. Inst. C.E.	Highway Surveyor to the Rural District Council, Croydon.
1899 June 29	Killick, P. G.	Borough Surveyor, Finsbury, E.C.
AM1911 Sept. 23 T1912 Feb. 10	Kilmister, C. H.	Works Department, Colombo Municipality, Ceylon.
AM1908 Apr. 25 T1911 July 29	*King, G. R.	Deputy Surveyor, Urban District Council, Twickenham.
G1906 May 26 TA1909 Mar. 27 TAM1911 July 29 T1912 Feb. 10	*King, J. S., A.M.Inst.C.E. ..	Assistant Surveyor, Urban District Council, Friern Barnet.
1902 May 10 R1903 July 25	Kinnison, A. M.	Abbey Cottage, Leek, Staffs.
1909 Mar. 27	Kirby, F. O., M.Sc.	Borough Surveyor, Doncaster.
A1904 Feb. 27 TAM1909 Oct. 30 T1911 July 29	Kirby, H. C.	Drainage Engineer, Pretoria, Transvaal.
1888 Sept. 15	Kirk, T.. Assoc. M. Inst. C.E.	City Engineer, Brisbane.
1907 May 25	Kirkpatrick, C. B. S., M.Inst. C.E.	Chief Assistant Engineer to Port of London Authority, 109 Leadenhall Street, E.C.
1895 Oct. 19	Knapp, R. W.	Borough Surveyor, Andover.
1903 June 25	*Knewstubb, J. J.	Surveyor to the Urban District Council, Penrith.
1907 Sept. 7	Kusakabe, B.	Chief Engineer to Municipality, Tokio, Japan.
1884 Oct. 9	Lacey, F. W., M.Inst.C.E. ..	Borough Engineer, Bournemouth.
G1893 Jan. 14 T1895 Mar. 16	*Lacey, G. W.	Borough Surveyor, Oswestry.
1909 July 17	Ladell, H. M.	Town and Water Engineer, Wynberg, Cape Colony.
1900 Dec. 15	Lailey, H. G. N.	Surveyor to the Urban District Council, Trowbridge.
1900 July 19	Laithwaite, V.	Surveyor to the Urban District Council, Turton, 2 Rigby Lane, Bradshaw, near Bolton.
AM1908 Sept. 5 T1911 July 29	Lake, T...	Highway and Building Surveyor, Rural District Council, Bourne, Lincs.
1904 Apr. 30	Lambert, A. P.	Resident Engineer, Port of London Authority, London Dock Improvement, Pierhead, Wapping, E.
A1902 Mar. 29 T1905 Oct. 28	Lancashire, W. T., M.Inst. C.E. (*Member of Council.*)	City Engineer, Leeds.
1904 Oct. 13	Landale, G.	Burgh Surveyor, Musselburgh.
AM1907 Sept. 7 T1911 Apr. 29	Lane, W. G.	Borough Surveyor and Water Engineer, Dartmouth.
1909 Sept. 4	*Langley, F...	Surveyor to the Urban District Council, Buxton.

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Date of Election and Transfer.		
1909 June 5	LAPHAM, A. H.	Surveyor to the Rural District Council, Chippenham.
A1901 Dec. 7 TAM1910 Jan. 22 T1911 July 29	LASHMORE, E. W., Assoc. M. Inst. C.E.	Divisional Engineer, City Engineer's Office, Bristol.
1884 July 10	LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
1910 Dec. 10 R1912 Jan. 13	LAWTON, C. E.	City Engineer's Department, Council House, Birmingham.
1900 Mar. 10	LAWTON, C. H.	Surveyor to the Urban District Council, Warminster. Christchurch Cottage, Warminster, Wilts.
1912 Apr. 27	LAYLAND, R. J. W.	Engineer and Surveyor, Rural District Council, Billericay.
G1899 Oct. 21 T1901 May 11	*LEA, M., A. M. Inst. C.E. ..	Engineer to the Municipality, Karachi, India.
1904 Aug. 31	LEE, J.	Burgh Surveyor, Paisley.
P1896 Oct. 24	LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.)
G1903 June 25 TA1906 Dec. 15 TAM1908 Dec. 5 T1911 July 29	*LEES, H. B.	P.W.D., Colombo, Ceylon.
G1906 Dec. 15 TAM1911 July 29 T1912 Jan. 13	*LEES, R. B.	Surveyor to the Urban District Council, Bradford-on-Avon.
1898 Mar. 19	LEETE, H. J. G.	County Surveyor, Huntingdon.
1880 Apr. 10	LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
1894 May 19	LEIGH, W.	Borough Surveyor, Chorley.
1873 Feb. 15	LEMON Sir J., M. Inst.C.E. (*Past President and Hon. Treasurer. Member of Council.*)	Stockwell Lodge, The Avenue, Southampton.
A1911 Jan. 21 TAM1911 July 29 T1912 Feb. 10	*LIGHBODY, T. H.	Surveyor to the Rural District Council, 20 Marlowes, Hemel Hempstead.
A1907 Sep. 7 TAM1909 Dec. 11 T1911 July 29	LILLEY, A. S...	Surveyor to the Urban District Council, Porthcawl, Glam.
AM1908 Dec. 5 T1911 July 29	LINGWOOD, G. W.	Surveyor, Urban District Council, Stowmarket.
G1901 May 11 TA1901 Oct. 19 TAM1908 Apr. 25 T1911 July 29	*LISMER, A. B., A.M.Inst.C.E.	Assistant Engineer, Town Hall, Edmonton.
G1896 July 25 T1899 Dec. 16 R1903 Feb. 21	*LIVERSEDGE, J. W.	Surveyor to the Urban District Council, Leigh-on-Sea, Essex.
1891 Mar. 21 R1901 Aug. 24	LIVINGSTONE, G., Assoc. M. Inst. C.E.	23 Wilbury Avenue, Hove.
G1909 Sept. 4 TAM1911 July 29 T1912 Feb. 10	*LLOYD, R. S.	Surveyor to the Rural District Council, Hereford. Oaklands, Bodenham Road, Hereford.
1907 May 25	*LLOYD-DAVIES, D. E., M.Inst. C.E.	Chief Engineer, The Municipality, Alexandria, Egypt.

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Date of Election and Transfer.		
1873 May 2	LOBLEY, J., M. Inst. C.E. (*Past President.*)	Richmond Terrace, Shelton Stoke-on-Trent.
1896 June 25	LOCKE, W. R.	Borough Surveyor, Town Hall Hemel Hempstead.
1889 Sept. 21	LOMAX, C. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Gorton. 37 Cross Street, Manchester.
1904 Mar. 26	LONGDIN, H. W.	Surveyor to the Urban District Council, Penge.
AM1910 July 16 T1911 July 29	LONGDIN, W. G.	Chief Assistant Engineer West Rangoon Municipality, Burma.
1896 Oct. 24	LONGFIELD, R. W. F., M. Inst. C.E.	County Surveyor, Co. Cork (W.), Bandon.
1903 Dec. 12 R1908 Feb. 29	LONGLEY, H. B.	Surrey Estate Offices, High Street, Epsom.
1911 Mar. 4	LOUDEN, J.	Burgh Surveyor, Bo'ness.
1901 May 11	LOVEDAY, W. F.	Borough Surveyor, Stoke Newington, N.
1892 Jan. 16	LOVEGROVE, E. J., M. Inst. C.E.	Borough Engineer, Hornsey, N.
1910 Dec. 10	LOW, W. D.	Master of Works and Burgh Surveyor, Greenock.
1897 July 8	LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
1896 July 25	LUND, C.	Surveyor to the Urban District Council, Cleckheaton.
1896 Oct. 24	LYNAM, F. J., Assoc. M. Inst. C.E.	County Surveyor, Co. Tyrone (N.).
G1888 July 12 T1897 Oct. 16	*LYNAM, G. T., M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
1912 Apr. 27	MACBEAN, D.	Chief Assistant Surveyor, Middle Ward, Lanarkshire County Council. Hamilton.
1905 Mar. 3	MCBETH, M. B.	Surveyor to Mid-Argyll District, Argyllshire County Council, County Buildings, Lochgilphead, Argyllshire.
1883 May 30	MACBRAIR, R. A., M.Inst.C.E.	City Engineer, Lincoln. *Hon. Sec.* East Midland District.
1912 Jan. 13	MCCURDIE, W. D. R.	City Engineer, Dunedin, N.Z.
1900 Feb. 10	MCDERMID, C.	Surveyor to the Urban District Council, Eston.
1912 Apr. 27	MCDONNELL, F. H.	Borough Engineer, Lyme Regis.
1897 Jan. 16	MACKENZIE, D.	District Master of Works, County Buildings, Dunfermline.
G1906 Dec. 15 TA1907 Nov. 2 TAM1911 July 29 T1912 Feb. 10	*MACKENZIE, W. H.	Assistant Borough Engineer, Bournemouth.
A1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	MCKENZIE, L. S., A.M.Inst. C.E. (*Member of Council.*)	City Engineer and Surveyor, Bristol. *District Representative*, Southern District.
1898 June 30	MCKILLOP, R.	Burgh Surveyor, Perth.

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Date of Election and Transfer.		
1912 Oct. 26	McLEAN, W. H.	Municipal Engineer, Khartoum City, Khartoum North and Omdurham, Egypt.
1906 Mar. 3	*MADEN, J.	Engineer to the Calcutta Improvement Trust, 5 Clive Street, Calcutta, India.
1898 Feb. 19	*MADIN, W. B.	Surveyor to the Urban District Council, Rushden.
1886 Dec. 18	MAIR, H., M. Inst. C.E. ..	Borough Engineer, Hammersmith, W.
G1905 May 27 TAM1910 May 24 T1911 July 29	*MAITLAND, W. H...	Council Offices, Hoylake.
1892 July 21	MANNING, G. W.	Surveyor to the Rural District Council, Staines.
A1903 Mar. 21 TAM1911 July 29 T1912 Feb. 10	MANNING, W. R., A.M.Inst. C.E.	Assistant Borough Surveyor, Town Hall, Chelsea.
G1904 May 28 TAM1911 July 29 T1912 Feb. 10	*MANSFIELD, F.	Borough Surveyor, Abergavenny
G1898 Jan. 15 T1901 Aug. 24	*MARKS, C. W...	Borough Surveyor, Wokingham.
1888 July 12	MARKS, H. C., M. Inst. C.E.	City Surveyor, Carlisle.
G1906 Apr. 28 TAM1909 Feb. 27 T1911 July 29	*MARSH, F. E.	Assistant Engineer, Water Department, Singapore, S.S.
1897 Mar. 13	MARSHALL, J...	Surveyor to the Malling Rural District Council, East Malling, Kent.
A1903 Jan. 17 T1907 Nov. 2	MARSHALL, L. P., M. Inst. C.E.	Chief Engineer, Rangoon Municipality.
1894 Mar. 3 R1908 May 23	MARTEN, H. J., Assoc. M. Inst. C.E.	18 Madeira Road, Streatham, S.W.
G1894 Jan. 13 T1907 Dec. 14	*MARTIN, E. B., A.M.Inst.C.E. (*Member of Council.*)	Borough Engineer, Rotherham. *District Representative*, North-Eastern District.
P1899 May 6	MASON, C. G., Assoc. M. Inst. C.E.	Borough Surveyor, Guildford.
1904 Oct. 22	MASSIE, C.	Water Engineer, Falkirk.
1890 Mar. 29	MASSIE, F., M. Inst. C.E. ..	Surveyor to the Rural District Council, Wakefield. *Chairman*, North-Eastern District.
1906 Apr. 28	MATHER, H. T.	Surveyor to the Urban District Council, Surbiton.
1912 Oct. 26	MATHISON, J.	Engineer and Surveyor to the Rural District Council, Langport, Somerset.
1912 July 11	MATTHEW, J. C., A.M. Inst. C.E.	Deputy Surveyor to the Urban District Council, Exmouth, Devon.
G1905 May 27 TAM1909 July 17 T1911 July 29	*MATTHEW, S.	61 Savile Road, Dewsbury.
1898 Dec. 17	*MATTHEWS, E. R., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Bridlington. *District Representative*, North-Eastern District.
1904 May 28	MAUDSLEY, C. W.	Surveyor to the Rural District Council, Alton, Hants.

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Date of Election and Transfer.		
1881 Dec. 10	MAWBEY, E. G., M. Inst. C.E. (*Past President.*)	Borough Engineer, Leicester. *Chairman*, East Midland District.
AM1911 July 5 T1911 July 29	MAXWELL, D...	Burgh Engineer's Office, Arbroath.
1912 Sept. 9	MAXWELL, T. H.	Surveyor to the Fylde Rural District Council, Kirklam, near Blackpool.
G1896 July 25 T1902 Sept. 6	*MAXWELL, W. H., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
G1898 Dec. 17 T1904 June 26	*MAY, C. G.	Deputy Colonial Engineer and Deputy Surveyor General, Penang, S.S.
1894 Oct. 20	MAYBURY, H. P., M.Inst.C.E. (*Member of Council.*)	County Surveyor, Kent. Maidstone.
1901 Aug. 24	MAYLAN, S.	Surveyor to the Rural District Council, Basford.
1889 May 18	MAYNE, C., M. Inst. C.E. ..	c/o Messrs. J. Pook, 63 Leadenhall Street, E.C.
1912 June 1	MEAD, J. B.	Deputy Borough Engineer, St. Helen's.
1883 Feb. 17	MEADE, T. DE COURCY, M.Inst.C.E.(*Past President.*)	City Surveyor, Manchester.
1912 July 27	MEESON, A. J.	Engineer and Surveyor to the Urban District Council, Brentwood, Essex.
A1911 Jan. 21 TAM1911 July 29 T1912 Feb. 10	*MERRETT, W. J.	Assistant County Surveyor, Redruth, Cornwall.
1903 June 25 R1908 Jan. 18	*METCALFE, A. J.	District Main Road Surveyor, Ashbourne.
AM1909 Sept. 4 T1911 July 29	*MILES, E. J.	Deputy Borough Engineer, West Hartlepool.
1912 July 27	MILLARD, G. A.	Surveyor to the Rural District Council, Axminster.
G1900 Apr. 21 TA1901 Dec. 7 TAM1908 Feb. 29 T1911 July 29	*MILLER, G. F.	Chief Assistant Borough Engineer's Office, Hastings.
1893 June 24	MILLER, H., M. Inst. C.E. ..	County Surveyor, East Suffolk, Ipswich.
1902 July 10	MILLER, H.	Surveyor to the Urban District Council, Heysham.
G1906 May 26 TA1908 June 25 T1910 Oct. 29	*MILNER, J. D., A.M.Inst.C.E.	District Engineer, P.W.D., British Uganda.
1897 Jan. 16	*MILNES, G. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
G1905 May 27 TAM1908 Dec. 5 T1911 July 29	*MINORS, E., B.Sc. Eng. (Lond.), A.M.Inst.C.E.	Chief Assistant, City Surveyor's Office, Worcester.
1912 Sept. 9	MITCHELL, G. C.	Assistant Borough Engineer, Stockton-on-Tees.
1874 May 23 R1910 Mar. 12	MITCHELL, J.	49 Richmond Road, Birkdale.
1912 Apr. 27	MOIR, R.	County Road Surveyor, South Ayrshire County Council. Maybole.

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[Date of Election] and Transfer.		
1896 Oct. 24	MONCUR, J., A.M. Inst. C.E.	County Highway Surveyor, County Buildings, Stafford.
1912 Mar. 2	MOON, R. C.	Chief Engineering Assistant, Nuneaton.
1898 Apr. 23	MORGAN, E. F.	Borough Road Surveyor, Croydon.
1907 May 25	MORGAN, E. L., A.M. Inst. C.E.	Borough Engineer, Bolton.
1895 July 27	MORGAN, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.
1892 July 11	MORGAN, J.	Surveyor to the Rural District Council, Pontardawe, Swansea.
1901 June 8	MORGAN, R. P.	Surveyor to the Urban District Council, Towyn.
1910 May 24	MORGAN, S. H., A.M. Inst. C.E.	Surveyor to the Urban District Council, Prestwich.
1874 May 1	MORGAN, W. B., Assoc. M. Inst. C.E.	Surveyor, Weymouth.
1905 Oct. 28	MORLEY, E.	Surveyor to the Urban District Council, Walthamstow.
G1899 June 10 TAM1911 July 29 T1912 Apr. 27	*MOSS, P. A.	Town Hall, Upper Street, Islington.
1893 Jan. 14 R1899 May 6	MOSS-FLOWER, T. J., A. M. Inst. C.E.	28 Victoria Street, Westminster, S.W., and Carlton Chambers, Baldwin Street, Bristol.
1903 Feb. 21	MOULDING, T., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Exeter. *Hon. Sec. and District Representative*, South-Western District.
1885 Feb. 7 R1905 Jan. 28	MOUNTAIN, A. H., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Barton-on-Irwell, Green Lane, Patricroft, near Manchester.
1898 Sept. 3	MULVANY, C. J., M. Inst. C.E.	County Surveyor, Co. Roscommon, Ranelagh House, Roscommon.
1904 Aug. 6	MURRAY, J.	County Surveyor, Renfrewshire, Paisley.
1904 Aug. 17	MURRAY, J.	Burgh Surveyor, Port Glasgow.
G1902 July 10 A1907 Jan. 19 TAM1910 Mar. 12 T1911 July 29	*NATHANIELSZ, A. H., A.M. Inst. C.E.	District Engineer, P.W.D., Anuradapura, Ceylon.
G1901 Aug. 24 TA1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	*NEAVE, J.	Chief Assistant, Engineer's Department, Town Hall, Walthamstow.
G1904 Dec. 3 TAM1910 Apr. 23 T1911 July 29	*NEEDHAM, J. E.	Engineering Assistant, P.W.D. Shanghai.
AM1910 Mar. 12 T1911 July 29	*NELSON, B. A.	Surveying Assistant to Borough Engineer, Southport.
1905 Oct. 28	NELSON, G., A.M. Inst. C.E.	Surveyor to the Urban District Council, Gosforth.
1897 July 8	NEWMAN, J. S.	Borough Surveyor, Poole.

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Date of Election and Transfer.		
G1906 Jan. 20 A1907 Nov. 2 TAM1910 Mar. 12 T1911 July 29	*Newman, W. W., A.M.Inst. C.E.	Deputy Surveyor, Council Offices, Watford, Herts.
1897 Feb. 13 R1903 Jan. 17	Newton, C. E., M.Inst.C.E.	19 Cooper Street, Manchester.
G1895 Jan. 19 TA1901 Oct. 19 T1902 Mar. 22	*Newton, E. B. B., M.Inst. C.E.	Borough Surveyor, Paddington, W.
1888 May 12	Newton, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
G1892 Sept. 24 T1899 Feb. 25	*Nichols, A. E., M. Inst.C.E.	Borough Engineer, Folkestone.
1904 Aug. 5	Nisbet, T., Assoc. M.Inst.C.E.	Master of Works, City Chambers, Glasgow.
1887 July 14 R1899 Feb. 25	Norrington, J. P.	78 Leander Road, Brixton Hill, S.W.
G1897 Mar. 13 T1898 Sept. 3	*Norris, J. H.	Borough Surveyor, Godalming.
1886 Dec. 18 R1901 May 11	Norrish, G. R.	Hawley House, Tudor Road, Upper Norwood.
1900 Dec. 15 R1910 Oct. 29	Nuttall, H., Assoc. M. Inst. C.E.	"The Laurels," Fulwood, Preston.
1912 July 11	Nuttall, J. B.	Borough Surveyor, Heywood.
1899 Feb. 25 R1908 Feb. 29	Nuttall, W.	2 Belgrave Place, Birkdale, Southport.
G1898 June 30 T1899 Oct. 21	*Oakden, R., A.M. Inst. C.E. ..	Surveyor to the Rural District Council, Newark.
A1902 Jan. 25 T1906 Nov. 3	Oakes, H. H.	Town Surveyor, Ventnor, I. of W.
1901 Aug. 24	O'Hara, H.	Surveyor to the Urban District Council, Ballymena, Ireland.
1910 Dec. 10	O'Sullivan, J. G., A.M.Inst. C.E.	City Engineer, Dublin.
G1901 Aug. 24 TAM1911 July 29 T1912 Feb. 10	*Oxberry, F. W.	Borough Engineer, Kendal.
1907 Mar. 2	Palk, D. S.	Provincial Engineer, P. W. D., Gold Coast, South Africa.
1896 Apr. 25	Palmer, F. W. J.	Surveyor to the Urban District Council, Herne Bay.
1912 Oct. 26	Palmer, G.	Assistant County Surveyor to the Cornwall County Council, Redruth.
P1900 Mar. 10	Palmer, P. H., M. Inst. C.E.	Borough Surveyor, Hastings.
1912 July 11	*Palmer, S.	Borough Surveyor and Water Engineer, St. Ives.
G1901 Feb. 6 TAM1911 July 29 T1912 Feb. 10	*Palmer, W. L. F., Assoc.M. Inst.C.E.	District Engineer, City Engineer's Office, Bristol.
1905 Jan. 28	Pansing, J., A.M. Inst. C.E.I.	Town Surveyor, Wicklow.
1894 Apr. 6	Pardoe, J. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Barry, near Cardiff.
1876 May 1	Parker, J., Assoc. M. Inst. C.E.	City Surveyor, Hereford.

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Date of Election and Transfer.		
1896 Nov. 28 R1903 Feb. 21	PARKER, J. E., A.M.Inst.C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
1896 Oct. 24	PARKER, S. W.	Surveyor to the Urban District Council, Gainsborough.
1893 July 13	PARR, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
G1902 Mar. 22 TA1904 Oct. 29 TAM1909 June 5 T1911 July 29 R1912 Jan. 13	*PARR, J. E., A.M. Inst. C.E.	City Engineer's Department, Council House, Birmingham.
G1893 Jan. 14 T1894 Oct. 20 R1908 Jan. 18	*PARR, N.	Brunswick House, Brentford.
1905 June 22	*PARRY, E.	District Main Road Surveyor, Hertforshire. Lancaster Avenue, Hitchin, Herts.
1912 Apr. 27	PARRY, T. R...	Surveyor to the Urban District Council, Barmouth.
G1906 June 28 TAM1909 July 17 T1911 July 29 R1912 Jan. 13	*PARSONS, A. S., A.M.Inst.C.E.	City Engineer's Department, Council House, Birmingham.
A1904 Sept. 5 TAM1911 July 29 T1912 Feb. 10	PATERSON, J. B.	Chief Assistant to City Engineer, Dundee.
P1894 June 21	PATON, J. (*Past President. Member of Council.*)	Borough Engineer, Plymouth.
1905 June 22	PATTINSON, N. P.	Borough Surveyor, Gateshead.
1895 Jan. 19	PATTISON, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
1897 Jan. 16	PEACOCK, T. J.	District County Surveyor, Holland County Council, Spalding.
1898 Dec. 17	PEARCE, F. W.	Surveyor to the Urban District Council, Twickenham.
1912 June 1	PERKINS, R. S. W.	County Surveyor, Southern Division, Isle of Ely.
G1903 Dec. 12 TAM1911 July 29 T1912 Mar. 2	*PERSEY, W. C.	Chief Assistant, Town Hall, Barrow-in-Furness.
1891 Dec. 12	PEIRCE, R., M. Inst. C.E. ..	Municipal Engineer, Singapore, S.S.
A1902 Mar. 22 T1906 Dec. 15	PHILLIPS, G. A., A.M.Inst.C.E. (*Member of Council.*)	County Surveyor, Glamorgan. Bridgend. *District Representative*, South Wales District.
1889 May 18 R1908 Jan. 18	PHILLIPS, R., Assoc. M. Inst. C.E.	9 Belgrave Road, Gloucester.
P1904 May 28	PHIPPS, F. R., Assoc.M. Inst. C.E.	Borough Surveyor, Basingstoke. *Hon. Sec.*, Southern District.
1901 Aug. 24	PICK, S. P.	County Surveyor, Leicester, 6 Millstone Lane, Leicester.
1901 Oct. 19	PICKARD, J. E.	Borough Surveyor, Pontefract. Yorks.
1898 Apr. 23	PICKER, E.	Engineer and Surveyor to the Rural Dist. Council, Beverley.
G1887 June 18 PT1890 Sept. 13	*PICKERING, J. S., M. Inst. C.E. (*Vice-President.*)	Borough Engineer, Cheltenham.

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Date of Election and Transfer.		
G1894 Jan. 13 T1895 Oct. 19	*Pickles, G. H., M. Inst. C.E.	Borough Engineer, Burnley.
1906 Mar. 3	Picton, T. S.	Borough Engineer, Eccles.
G1904 May 28 TAM1911 June 10 T1911 July 29 R1912 Jan. 13	*Piercy, M. A.	Chief Assistant, Borough Surveyor's Office, Stoke.
G1899 Oct. 21 A1904 June 25 AM1908 July 18 T1910 Sept. 17	*Plant, Wm., A.M.Inst.C.E.	Borough Engineer, Stafford.
P1881 Dec. 10	Platt, S. S., M. Inst. C.E.	Borough Surveyor, Rochdale.
AM1911 Mar. 4 T1911 July 29	Pole, E. C.	Deputy County Surveyor, Glamorganshire. Braeside, Bridgend.
1897 July 8	Poole, H. C.	c/o D. J. Poole, Town Hall, Tiverton, Devon.
G1907 Mar. 2 TAM1911 Mar. 4 T1911 July 29	*Poulden, G. E. L., A.M.Inst. C.E.	Resident Engineer on Water Supply, c/o Treasurer, Zanzibar.
1899 Jan. 21	Powell, J.	Town Engineer, East London, Cape of Good Hope.
AM1911 Mar. 4 T1911 July 29	*Powell, W. G.	City Engineer's Office, Norwich.
1899 Oct. 21	*Prescott, A. E.	Borough Surveyor, Eastbourne.
1898 Mar. 19	Prescott, W. H., M. Inst. C.E. (*Member of Council.*)	Surveyor to the Urban District Council, Tottenham, N. *District Representative*, Eastern District.
G1894 June 21 T1899 June 29	*Price, A. J.	Surveyor to the Urban District Council, Lytham.
A1910 Jan. 22 TAM1911 July 29 T1912 Feb. 10	*Price, D. H.	Surveyor to the Urban District Council, Bedwellty.
1909 Dec. 11	Priestley, C. H., M. Inst.C.E.	Waterworks Engineer, Cardiff.
AM1910 July 16 T1911 July 29	Pritchard, H.	Surveyor to the Rural District Council, Burnley, Lancs.
1904 Sept. 29	Pritty, J.	Burgh Engineer, Selkirk.
1873 May 2	Proctor, J., M. Inst. C.E. ..	Mere Lawn, Bolton, Lancashire.
1892 May 28	Prouse, O. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Ilfracombe.
1904 Aug. 4	Purdie, W. H.	Burgh Engineer, Hamilton.
1899 May 6	Purser, W. B., A.M. Inst. C.E.	County Surveyor, Kesteven County Council. Grantham.
G1893 July 31 T1898 June 13	*Putman, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
1905 Dec. 9	Putten, E. Van, M.Inst.C.E.	Borough Engineer, Lewisham, Town Hall, Catford, S.E.
G1904 Dec. 3 TAM1911 July 29 T1911 Sept. 23	Quirk, J. J.	Surveyor to the Urban District Council, Brynmawr.
A1903 Dec. 12 T1909 Dec. 11	*Race, A.	Borough Engineer, Barrow-in-Furness.
1886 Dec. 18 R1901 Oct. 19	Radford, J. C., A. M. Inst. C.E.	163 Upper Richmond Road, Putney, S.W.

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Date of Election and Transfer.		
AM1910 May 24 T1911 July 29	RAINE, W. S.	Highway and Building Surveyor, Rural District Council, Hungerford.
A1902 Mar. 22 TAM1907 Dec. 14 PT1911 July 29	RANSOM, W., A. M. Inst. C.E.	Assistant City Surveyor, Worcester.
1889 July 4	RAPLEY, W.	Surveyor to the Rural District Council, Dorking.
1908 May 23	RAWSON, G.	Surveyor to the Urban District Council, Worksop.
G1901 June 8 TAM1911 July 29 T1912 Feb. 10	*READ, F., Assoc.M.Inst.C.E.	Public Offices, Pentre, Rhondda.
1878 May 1 G1897 June 19	READ, R., A.M.Inst. C.E. ..	City Surveyor. Gloucester. *Chairman*, Southern District.
TA1901 Dec. 7 T1904 Sept. 17	*REDFERN, J. L. .. .. .. (*Member of Council.*)	Borough Surveyor, Gillingham, Kent. *District Representative*, South-Eastern District.
1892 Mar. 11	REYNOLDS, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
G1899 Mar. 25 A1907 Jan. 19 T1910 Mar. 12	*RICHARDS, E. P.	City Engineer, Madras.
1888 July 12 R1902 Feb. 22	RICHARDS, R. W., M. Inst. C.E.	350 George Street, Sydney, N.S.W. *Hon. Corresponding Secretary* for Australasia.
1888 May 12 R1912 Jan. 13	RICHARDSON, H., Assoc. M. Inst. C.E.	Council House, Handsworth, Birmingham. *Hon. Secretary*, West Midland District.
AM1907 Sept. 7 T1911 July 29	RICHARDSON, H.	Deputy Borough Surveyor, Scarborough.
1884 Oct. 9	RICHARDSON, J.	County Surveyor, Rutland. Stamford.
AM1911 Mar. 4 T1911 July 29	RICHARDSON, J. F., M.A. ..	City Engineer's Office, Oxford.
1901 May 11	*RIDLER, W.	Borough Surveyor, Tewkesbury.
1892 Mar. 11 G1901 Aug. 24	RIDOUT, A. R.	Surveyor to the Urban District Council, Stone.
TA1905 Dec. 9 T1906 June 28	*RILEY, J.	Engineer to Irrigation and Water Supply Dept., Pretoria, Transvaal, S.A.
G1891 Dec. 12 T1897 Mar. 13	*ROBERTS, F., A. M. Inst.C.E.	Borough Engineer, Worthing. *Hon. Sec.*, South-Eastern District.
AM1910 Dec. 10 T1911 July 29	ROBERTSON, A. S., A.M.Inst. C.E.	City Engineer's Office, Edinburgh.
1912 July 11	ROBERTSON, R.	County Road Surveyor, Inverness, N.B.
A1904 Aug. 5 TAM1910 Dec. 10 T1911 July 29	ROBERTSON, R.	P.W.D., Pretoria, Transvaal, S.A.
1909 Sept. 4	ROBINSON, M. A.	City Engineer, Londonderry, Ireland.
1891 Oct. 17	ROBINSON, W. P., A.M. Inst. C.E.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
A1906 May 26 TAM1911 July 29 T1912 Apr. 27	ROBINSON, W. P., B.Sc. (Vict.), A. M. Inst. C.E.	County Surveyor, Devon County Council, The Castle, Exeter.

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Date of Election and Transfer.		
1876 May 1	ROBSON, O. C., M. Inst. C.E. (*Past President.*)	Engineer to the Urban District Council, Willesden, Middlesex.
G1907 Dec. 14 T1910 Jan. 22	*RODDAN, T. K.	Burgh Surveyor, Broughty Ferry.
1896 Mar. 21	RODWELL, A.	Surveyor to the Rural District Council, Skipton.
1896 Jan. 18	ROGERS, W. E.	Surveyor to the Urban District Council, Rugely.
1904 Oct. 22	RONALD, D.	Burgh Engineer, Falkirk. *Hon. Sec.*, Scottish District.
1895 Jan. 19	ROSS, J. C., A.M. Inst. C.E. ..	Engineer of Water Supply, City Hall, Toowoomba, Queensland, Australia.
G1903 June 6 A1904 Mar. 26 AM1908 Feb. 29 T1910 Mar. 12	*ROSEVEARE, L., A.M.Inst.C.E.	Borough Engineer, South Shields.
G1901 Feb. 16 T1905 Mar. 3	*ROTHERA, A.	Surveyor to the Urban District Council, Liversedge.
1880 Oct. 2 R1905 May 27	ROUNTHWAITE, R. S., M. Inst. C.E.	4 Willis Street, Wellington, New Zealand.
G1900 Jan. 16 T1909 Feb. 27	*ROUSSELL, A. J., A.M.Inst. C.E.	Surveyor to the Urban District Council, Whitley and Monkseaton.
A1902 Nov. 8 TAM1911 July 29 T1912 Feb. 10	ROWBOTTOM, J.	Deputy Borough Surveyor, Ashton-under-Lyne.
1888 May 12	RUCK, F. W.	County Architect, 86 Week Street, Maidstone.
1895 Feb. 16	RUSHBROOKE, T. J.	Borough Surveyor, High Wycombe.
1896 Apr. 25	*RUSHTON, E.	Surveyor to the Urban District Council, Cleethorpes.
1912 Oct. 26	RYDER, E. E.	Engineer and Surveyor to the Urban District Council, Bushey.
A1903 Mar. 21 T1904 Sept. 17	RYMAN, F. R., A.M.Inst.C.E.	Borough Surveyor, Stamford.
A1903 June 6 AM1908 Sept. 5 T1910 Oct. 29	SADLER, F.	Engineer and Surveyor to the Urban District Council, Acton.
1890 Mar. 29 R1904 Mar. 26	*SAISE, A. J., Assoc. M. Inst. C.E.	Ventnor House, Forest Road, Fishponds, Bristol.
1899 Feb. 25	SALKIELD, T.	Chief Engineer to Municipality of Delhi, India.
A1903 June 25 T1906 Dec. 15	*SAUNDERS, E. Y.	Borough Surveyor, Barnstaple.
G1887 June 18 T1898 May 21 R1903 Mar. 21	*SAUNDERS, J., A.M. Inst. C.E.	86 Appleton Gate, Newark-on-Trent.
AM1911 June 10 T1911 July 29	*SAUNDERS, R...	Borough Surveyor's Office, Gravesend.
G1894 Oct. 20 A1902 May 10 TAM1909 Dec. 11 T1911 July 29	*SAVAGE, E. B., A.M. Inst. C.E.	Superintending Engineer, Sewers and Rivers Department. Council House, Birmingham.

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Date of Election and Transfer.		
1911 June 10	SAVAGE, W. H.	The Grange, Cockfosters, Herts.
1894 Mar. 3	SAVILLE, J.	Town Surveyor, Heckmondwike.
G1906 May 26 TAM1911 July 29 T1912 Feb. 10	*SAWDON. J. S.	Chief Assistant, Borough Surveyor's Office, Margate.
1899 May 6	SCHOFIELD, W. H., A.M. Inst. C.E.	County Surveyor, Lancashire. County Hall, Preston.
1894 June 21	SCORGIE, N., M. Inst. C.E. .. (*Member of Council.*)	Borough Surveyor, Hackney, N.E. *Hon. Sec. and District Representative*, Metropolitan District.
1888 Nov. 17	SCOTT, H. H., A.M.Inst.C.E.	Borough Surveyor, Hove.
1880 May 27	SCOTT, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
1897 Feb. 13	SCOTT, T.	Highway Surveyor to the Rural District Council, Tadcaster. Aberford, near Leeds.
1904 Aug. 4	SCOTT, T. H	Burgh Surveyor, Inverness.
1912 Sept. 9	*SEELS, G. W...	Assistant Engineer and Surveyor to the Urban District Council, New Malden, Surrey.
1909 Mar. 27	SELLARS, M.	Town Surveyor, Dundalk, Ireland. *Hon. Sec.*, Irish District.
1897 July 8	SENIOR, C. E...	Surveyor to the Urban District Council, Neston, Cheshire.
1896 Oct. 24	SENIOR, J. S.	Surveyor to the Urban District Council, Swanage.
G1894 July 7 T1898 Mar. 19	*SETTLE, J. A., A.M.Inst.C.E.	Borough Engineer and Surveyor, Bury, Lancs.
A1902 Nov. 8 T1907 Mar. 2	*SHACKLETON, W., A. M. Inst. C.E.	Borough Surveyor, Nelson.
1896 Nov. 28	SHARPE, J. E.	Surveyor to the Urban District Council, Cheshunt.
1891 June 6	SHAW, H., M. Inst. C.E. ..	Surveyor to the Urban District Council, Ilford.
1890 June 7 R1901 Aug. 24	SHAW, J. H.	Surveyor to the Urban District Council Brownhills, Staffs.
1892 May 28	SHEARD, W. C., Assoc.M. Inst. C.E.	Surveyor to the Urban District Council, New Mills. "Stonelea," New Mills, near Stockport.
1905 June 22	SHELL, W. S.	Surveyor to the Urban District Council, Consett, Durham.
G1902 July 10 TAM1908 Sept. 5 T1911 July 29	*SHEPHERD, G. G.	Chief Assistant, Engineer's Office, Urban District Council, Ilford.
1891 Oct. 17	SHEPHERD, G. J.	Surveyor to the Rural District Council, Kidderminster.
1884 June 10	SHEPPARD, G.	Borough Surveyor, Newark.
A1905 May 27 T1907 May 25	SHERREN, A. O., A.M.Inst.C.E.	Surveyor to the Urban District Council, Cheriton.
1892 July 11	SHILLINGTON, H., M.E. ..	Town Surveyor, Lurgan, Ireland.
1895 Oct. 19	SHIPTON, T. H.	Surveyor to the Urban District Council, Oldbury.

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Date of Election and Transfer.		
1902 June 7	SIDDALLS, J.	Borough Surveyor, Tiverton.
1887 Oct. 22	SIDDONS, J. M.	Surveyor to the River Nene Commissioners, Oundle.
1896 Jan. 18	SIDWELL, H. T.	Surveyor to the Rural District Council, Rochford. Rayleigh, Essex.
P1887 July 14 R1898 Oct. 15	*SILCOCK, E. J., M. Inst. C.E.	11 Tothill Street, Westminster.
1897 Mar. 13	SILCOCK, H.	Surveyor to the Rural District Council, Blackwell. 67 Westgate, Mansfield.
AM1910 Apr. 23 T1911 July 29	SILLITOE, W. C., A.M.Inst.C.E.	Chief Assistant to Borough Engineer, Ealing, W.
1903 Oct. 17	SIMMONS, T. B.	Surveyor to the Rural District Council, Wigton.
1901 Feb. 16	SIMPSON, H. FARR	County Surveyor, Northern Division, Isle of Ely. Wisbech.
1906 Dec. 15	SIMS, A.	Surveyor to the Rural District Council, Ashford.
AM1907 Sept. 7 T1911 July 29	SIMS, S. B.	Borough Engineer, Hamilton, N.Z.
1890 Sept. 13	SINCLAIR, J. S., A.M.Inst.C.E.	Borough Surveyor, Widnes.
1912 July 11	SINCLAIR, P.	Borough Surveyor, Carnoustie.
1908 July 18	SINNOTT, E. S., M. Inst. C.E.	County Surveyor, Gloucestershire. Gloucester.
G1905 May 27 TAM1909 Jan. 23 T1911 July 29 R1912 Jan. 13	*SISSONS, F. P.	District Surveyor's Office, Queen Street, Burslem.
1895 Oct. 19	SKELTON, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
G1905 Oct. 28 TAMP1911 July 29 T1912 Feb. 10	*SLATER, E. A.	Deputy Borough Surveyor, Colchester. 201 Malden Road, Colchester.
G1899 Dec. 16 TA1902 May 10 TAM1908 Feb. 29 T1911 July 29	*SLATER, F. J.	Assistant Surveyor, Town Hall, Camberwell, S.E.
1912 Oct. 26	SLAUGHTER, F., A.M.Inst.C.E.	Engineer and Surveyor to the Steyning West Rural District Council.
1898 Oct. 15	SMAIL, J. M., M. Inst. C.E. ..	Chief Engineer to the Metropolitan Board of Works, Sydney, N.S.W.
G1906 June 28 TAM1908 Sept. 5 T1911 July 29	*SMALL, L. J.	Assistant Surveyor, Council Offices, Woodford Green.
1895 June 27	SMILLIE, J. F.	Borough Surveyor, Tynemouth.
A1909 June 5 TAM1911 July 29 T1912 Mar. 2	*SMITH, A. E.	Surveyor to the Urban District Council, Hay, via Hereford.
1892 Mar. 11 R1910 Apr. 29	SMITH, C. CHAMBERS	53 Victoria Street, S.W.
A1904 May 28 TAM1911 July 29 T1912 Feb. 10	*SMITH, C. P.	Assistant Borough Engineer, Town Hall, Greenwich.
1902 Sept. 6	SMITH, F. H.	Surveyor to the Urban District Council, Portishead.

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Date of Election and Transfer.		
G1904 May 28 T1904 Sept. 17	*Smith, F. Hall	Surveyor to the Urban District Council, Sheringham.
A1906 Apr. 28 T1911 June 10	Smith, H. J. T., A.M.Inst.C.E.	Water Engineer, Bombay.
1899 Mar. 25	Smith, H. W., A.M. Inst. C.E.	Borough Engineer, Scarborough.
1912 Jan. 13	Smith, J. D.	County Surveyor, Dalbeattie, Kirkcudbright County Council.
1901 Dec. 7	Smith, J. Gould, A.M. Inst. C.E.	Borough Surveyor, Beverley.
1905 Jan. 28	*Smith, J. H. Woolston, A. M. Inst. C.E.	Surveyor to the Urban District Council, Minehead.
G1898 Dec. 17 TA1901 Oct. 19 T1903 Oct. 17	*Smith, J. Walker	Local Government Board of Scotland, George Street, Edinburgh.
P1904 Aug. 6	Smith, P. C.	Burgh Surveyor, Arbroath.
P1891 Dec. 12	Smith, T. R.. A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
1897 Jan. 16	Smith, V.	Borough Surveyor, Chesterfield
G1888 Jan. 14 T1897 Mar. 13	*Smith-Saville, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
G1905 Mar. 4 TAMP1911 July 29 T1912 Jan. 13	*Snape, A. E., M.Sc., A.M.Inst. C.E.	Professor of Civil Engineering, South African College, Cape Town, S.A.
A1907 Jan. 19 TAM1907 Nov. 2 T1911 July 29	Snodgrass, R., A.M.Inst.C.E.	Deputy Borough Engineer, Guildford.
1912 Sept. 9	*Snook, H. V..	Surveyor to the Rural District Council, Petersfield, Hants.
AM1908 Dec. 5 T1911 July 29	Southwart, J.	Surveyor, Urban District Council, Rothwell, near Leeds.
1903 Oct. 17	Sowden, M.	Surveyor to the Urban District Council, Whitchurch, Salop.
1898 Dec. 17	Spencer, J.	Surveyor to the Urban District Council, Oakworth. York Chambers, Cooke Street, Keighley.
1873 May 2 R1881 Dec. 10	Spencer, J. P., A.M.Inst.C.E.	30 Howard Street, North Shields.
1902 May 10	Spencer, L. G. P., A.M. Inst. C.E.	Borough Engineer, Te Kuiti, New Zealand.
1912 Apr. 27	Spittall, R.	County Road Surveyor, Middle Ward, Lanarkshire County Council. Hamilton.
G1899 Dec. 16 TA1901 Oct. 19 T1904 July 14	*Spreckley, J. A.. Assoc. M. Inst. C.E.	Borough Surveyor, Ludlow.
A1901 Dec. 7 T1908 May 23	Spurr, F. W....	City Engineer, York.
A1904 May 28 T1906 Nov. 3	Spurrell, E. F.	Borough Surveyor, Holborn.
1880 Feb. 7 R1899 June 10	Stainthorpe, T. W., A.M.Inst. C.E.	P.W.D., Irrigation Department, P.O. Box 23, Cape Town, South Africa. *Hon. Sec.*, African District.
1889 Dec. 14	Stallard, S.. A.M. Inst. C.E.	County Surveyor, Oxfordshire. Oxford.

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Date of Election and Transfer.		
G1895 Jan. 19 A1901 Oct. 19 AM1907 Nov. 2 T1910 Apr. 23	*STEELE, W. J.	City Engineer, Newcastle-on-Tyne.
1911 Apl. 29	STEPHENS, R.	Engineer to the Rural District Surveyor, Chard.
1892 Mar. 11	STEPHENSON, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
1892 Mar. 11	STEVENSON, A.	County Road Surveyor, Ayrshire County Council. Ayr.
1891 Oct. 17	STEVENSON, J.	Surveyor to the Urban District Council, East Molesey.
1901 Feb. 16	STEWART, J.	Boro' Engineer, Dunstable, Beds.
AM1908 Apr. 25 T1911 July 29	STEWART, R. T.	Engineer, Rural District Council, Aylesbury.
1891 June 25	STICKLAND, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
1897 Jan. 16	STILGOE, H. E., M. Inst. C.E. (*Member of Council*)	City Engineer, Birmingham. *District Representative*, West Midland District.
1900 Dec. 15	STIVEN, E. E.	Borough Surveyor, Whitehaven.
1904 Jan. 23	*STONES, J.	Surveyor to the Rural District Council, Sedgfield, co. Durham.
1910 Sept. 17	*STRICKLAND, W.	District Surveyor, Ramsbury Rural District Council, Wilts.
1880 May 27	STUBBS, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
AM1911 June 10 T1911 July 29	*SUGARS, W.	Engineer and Surveyor, Urban District Council, Horbury.
G1892 July 11 T1892 Sept. 24	*SUMNER, F., M. Inst. C.E. ..	City Engineer, Guildhall, London, E.C.
G1907 Jan. 19 T1907 May 25	*SUNDERLAND, C. H.	Surveyor to the Urban District Council, Midsomer Norton.
1895 Mar. 16	*SURTEES, R. T.	Water Engineer to the Urban District Council, Newton-in-Makerfield. Newton-le-Willows, Lancs.
A1903 Mar. 21 TAM1908 Sept. 5 T1911 July 29	SUTCLIFFE, H.	Deputy Borough Engineer, Huddersfield.
1909 Sept. 4	SUTCLIFFE, J., A.M. Inst. C.E.	Borough Surveyor, Deptford, S.E.
G1904 May 28 TAM1908 May 23 T1911 July 29	*SUTHERLAND, D. S.	Chief Assistant Surveyor, Southgate.
1904 Aug. 10	SUTHERLAND, J. R., M. Inst. C.E.	Chief Engineer, Water Department, City Chambers, Glasgow.
G1899 June 29 T1901 June 27	*SWALES, T. R.	Borough Surveyor, Maldon.
A1905 Sept. 23 TAM1907 Nov. 2 T1911 July 29	SWARBRICK, G.	Deputy Borough Surveyor. Swansea.
1880 June 23 E1889 Apr. 13	SWARBRICK, J., M. Inst. C.E.	30 St. Anns Street, Manchester.
AM1910 Apr. 23 T1911 July 29	*SWINSTEAD, E. W.	Assistant Surveyor. Western Division, Town Hall St. Pancras.
1899 June 10	SYKES, M. H.	Borough Surveyor, Stockton on-Tees.

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Date of Election and Transfer.			
G1902	Feb. 22		
TA1904	Dec. 3	*TAIT, W. I., A.M. Inst. C.E.	Borough Engineer, Sudbury, Suffolk.
T1906	Nov. 3		
1887	Mar. 12	TANNER, W.	County Surveyor, Monmouthshire. Newport.
1891	Mar. 21	TAYLOR, H. W., Assoc. M.	Cathedral Buildings, Dean St.,
R1903	Mar. 21	Inst. C.E.	Newcastle-on-Tyne.
G1898	Dec. 17		
TA1902	Jan. 25	*TAYLOR, J.	Borough Engineer, Walsall.
T1907	Sept. 7		
G1900	Dec. 15		
TA1903	May 16	*TAYLOR, P.	Surveyor to the Urban District
T1907	May 25		Council, Hampton Wick.
1890	Sept. 13	TAYLOR, T. G.	Borough Surveyor, Ramsgate.
1909	Feb. 27	TAYLOR, W. H.	Surveyor to the Urban District Council, Aylesbury.
G1891	Sept. 12		
T1897	Oct. 16	*TAYLOR, W. J., M. Inst. C.E.	County Surveyor, Hants. Winchester.
1892	Apr. 23	TERRILL, W.	Surveyor to the Urban District Council, Ashford, Kent.
G1899	June 10		
TA1905	Sept. 23		
TAM1911	July 29	*THACKERAY, J. R.	Deputy Borough Surveyor,
T1912	Feb. 10		Eastbourne.
G1907	June 20		
TA1907	Nov. 2		
TAM1911	July 29	*THACKRAY, F. J.	Surveyor to the Urban District
T1912	Mar. 2		Council, Hoyland Nether.
1892	Mar. 11	*THOMAS, R. J., M. Inst. C.E. (*President.*)	County Surveyor, Buckinghamshire. Aylesbury.
1890	May 3	THOMAS, T. J., A.M.Inst.C.E.	Surveyor to the Urban District Council, Ebbw Vale.
1902	May 10	THOMAS, W. B.	Surveyor to the Urban District Council, Southwick-on-Wear.
1887	Sept. 17	THOMAS, W. E. C., A.M. Inst. C.E.	Surveyor to the Rural District Council, Neath.
A1904	June 25		
TAM1911	July 29	*THOMPSON, W., Assoc.M.Inst.	Deputy Borough Engineer,
T1912	Feb. 10	C.E.	Burton-on-Trent.
1906	Nov. 3	THOMSON, J.	City Engineer, Dundee.
G1904	June 25		
T1906	Nov. 3	*THORP, W. O.	Surveyor to the Urban District Council, Malvern.
1891	Jan. 21	THORPE, J.	Surveyor to the Rural District Council, Macclesfield.
1898	Jan. 15	THROPP, J., M. Inst. C.E. ..	County Surveyor, Lincolnshire. 29 Broadgate, Lincoln.
G1898	June 30		
T1903	Dec. 12	*TIFFIN, T. E., A.M. Inst. C.E.	Surveyor to the Urban District Council, Dartford, Kent.
G1891	June 6		
T1893	Oct. 21	*TOMES, G. B., A.M. Inst. C.E.	Surveyor to the Urban District Council, Barnes, Mortlake.
G1902	July 10		
AM1908	Apl. 25	*TOMLINSON, J. W.	Borough Engineer, Luton.
T1910	Sept. 17		
1895	Mar. 16	TOOLEY, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.

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Date of Election and Transfer.		
1890 May 3	TOWLSON, S., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
G1900 June 16 TAM1907 Sept. 7 T1911 July 29	*TOWNER, H. V., A.M.Inst.C.E.	Executive Engineer, P.W.D., Singapore.
1894 Oct. 20	TRAVERS, W. H.	Surveyor to the Urban District Council, Wallasey.
G1900 June 16 T1910 Dec. 10	*TREMELLING, H., A. M. Inst. C.E.	Borough Engineer, Newport, Mon.
1912 June 1	TRIFFITT, C.	Deputy City Surveyor, York.
1901 Feb. 16	TROWSDALE, T. J.	Surveyor to the Urban District Council, Annfield Plain. Hare Law, Annfield Plain, Co. Durham.
AM1909 Dec. 11 T1911 July 29	TRUSLER, G. D.	City Engineer's Office, Guildhall, E.C. The Downs, Beeches Avenue, Carshalton.
1893 Oct 21	TURLEY, A. C., A.M.Inst.C.E.	City Engineer, Canterbury.
AM1910 Mar. 12 T1911 July 29	TURNER, F., B.Sc. Eng. (Lond.), A.M. Inst. C.E. ..	Chief Assistant to Borough Surveyor, Morley.
1899 June 10	*TURNER, S.	Surveyor to the Rural District Council, Ashby-de-la-Zouche.
1898 June 30	TURRIFF, A. A.	Burgh Surveyor, Elgin.
1905 May 27	*UREN, F. C., M. Inst.C.E.I. ..	Surveyor to the Urban District Council, Aldershot.
G1911 June 10 TAM1911 July 29 T1912 Apr. 27	*VANSTONE, F. W. E.	Engineering Assistant, Urban District Council, Paignton.
AM1911 Apr. 29 T1911 July 29	*VAWSER, C., A.M.Inst.C.E.I.	"Roseneath," Hadley Road, New Barnet.
G1894 Jan. 13 T1901 Dec. 7 R1903 Feb. 21	*VEIT, L. J.	1 Pimlico Road, S.W.
1889 Sept. 21 R1903 Jan. 17	VENTRIS, A., Assoc. M. Inst. C.E.	Westminster City Hall, W.C.
AM1911 Apr. 29 T1911 July 29	VINCENT, E. E. L., A.M.Inst. C.E.	Surveying Assistant, Port of London Authority. 44 Caterham Road, Lewisham, S.E.
1897 June 19	VINCENT, S. J. L., A.M. Inst. C.E.	Borough Surveyor, Newbury.
1911 Apl. 29	WADDINGHAM, T.	Engineer and Surveyor to the Urban District Council, Hebden Bridge.
1894 June 21	WADDINGTON, J. A. P., M. Inst. C.E.	Borough Engineer, Marylebone, W.
AM1910 Oct. 29 T1911 July 29	WAINWRIGHT, W. H., A.M.Inst. C.E.	City Engineer's Office, Edinburgh.
1907 Dec. 14	*WAITHMAN, C. H.	Surveyor to the Urban District Council, Town Hall, Cleethorpes, Lincs.
1902 June 7	WAKEFORD, J. P., A. M. Inst. C.E.	City Surveyor, Wakefield. *Hon. Secretary*, North-Eastern District.

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Date of Election and Transfer.		
1888 July 12	WAKELAM, H. T., M. Inst. C.E. (*Member of Council.*)	County Engineer, Middlesex. 63 Victoria Street, Westminster, S.W. *District Representative*, Eastern District.
1898 Sept. 3	WALKER, A. H., A. M. Inst. C.E.	Borough Surveyor, Loughborough.
G1900 Dec. 15 T1904 Jan. 23	*WALKER, H.	Surveyor to the Urban District Council, Wealdstone.
1887 June 18	WALSHAW, J. W.	Borough Surveyor, Peterborough.
1912 July 11	WALTERS, J. R.	Borough Surveyor, Congleton.
G1904 May 28 TA1904 Dec. 3 TAM1907 Dec. 14 T1911 Jan. 21	*WALTON, J. S.	Borough Engineer, Falmouth.
1905 Sept. 23	WARBURTON, W. E.	Surveyor to the Urban District Council, Hornsea.
A1905 Sept. 23 TAM1909 June 5 T1911 July 29	WARD, A. W., A.M. Inst. C.E.	Deputy Borough Engineer, Stockport.
1899 Jan. 21	WARD, J., M. Inst. C.E. ..	Borough Engineer, Derby.
1886 July 8 R1912 Jan. 13	WARDLE, J. W., A.M.Inst.C.E.	341 Uttoxeter Road, Longton, Stoke-on-Trent.
G1904 May 28 T1904 Sept. 17	*WARE, G. W.	Surveyor to the Urban District Council, Southwick.
1890 May 3	WATERHOUSE, D.	Surveyor to the Urban District Council, Watford.
1912 Apr. 27	WATSON, J.	County Road Surveyor, Middle Ward, Lanarkshire County Council. Strathaven.
1887 June 18	WATSON, J. D., M. Inst. C.E.	Engineer to the Birmingham, Tame and Rea Drainage Board, Tyburn, near Birmingham.
AM1909 July 17 T1911 July 29	*WATSON, R. H. H.	County Engineer's Office, Reading.
1904 Aug. 10	WATSON, W.	Burgh Surveyor, St. Andrews.
1889 Sept. 21	WATTS, E. T.	Surveyor to the Rural District Council, Hadham and Stansted, Bishop's Stortford.
1909 July 17	*WATTS, T. N. W.	Surveyor to the Urban District Council, Marlow.
1887 June 18	WEAVER, W., M. Inst. C.E. (*Past President.*)	30 Lytton Grove, Putney Hill, S.W.
1897 Feb. 13	WEBB, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
1901 Oct. 19	WEBSTER, J. W.	Surveyor to the Urban District Council, Cowes, Isle of Wight.
1905 Jan. 28	WEBSTER, R. A.	Town Engineer, Krugersdorp, Transvaal, S.A.
G1899 June 10 TA1902 Mar. 2 T1911 Jan. 21	*WEIR, J. S., A.M.Inst.C.E. ..	Borough Engineer, Jarrow-on-Tyne.
1882 Apr. 15	WELBURN, W.	Borough Surveyor, Middleton, near Manchester.
1887 June 18 R1903 Feb. 21	WESTON, G.	The Limes, Harrow Road, Pinner.

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Date of Election and Transfer		
1889 Apr. 13 R1903 Jan. 17	WESTON, H. J., Assoc. M. Inst. C.E.	24 Portland Street, Southampton.
1907 May 25	WHEELER, A. G.	Surveyor to the Urban District Council, Eastwood.
P1888 July 12	WHITE, A. E., M. Inst. C.E. ..	City Engineer, Hull. .
G1902 Jan. 25 TAM1911 July 29 T1911 Oct. 21	*WHITE, C. D.	Surveyor to the Urban District Council, Newton Abbot.
AM1909 June 5 T1911 July 29	WHITE, H. A.	Engineer's Office, Town Hall, Battersea.
1891 Oct. 17 R1909 June 5	WHITE, H. V., M. Inst. C.E. I.	St Helens, Ailesbury Park, Dublin.
1900 Mar. 10	WHITE, J. N.	Borough Surveyor, Stalybridge.
1873 May 2	WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
A1903 May 16 TAM1911 July 29 T1912 Feb. 10	WHITE, W. H. J., Assoc.M. Inst.C.E.	Deputy Borough Engineer, Town Hall, Cheltenham.
1912 Feb. 10	WHITEHEAD, H. C.	Chief Assistant, Boro' Engineer's Office, Southend-on-Sea.
A1909 June 5 TAM1911 July 29 T1912 June 1	*WHITEHEAD, S.	Water Engineer and Manager, Nelson, Lancs.
1910 Oct. 29	WHITFIELD, A. G...	Chief Sanitary Engineer, P.W.D., Secondee, Gold Coast.
1912 Apr. 27	WHITWELL, E.	Surveyor to the Urban District Council, Abersychan.
1900 Aug. 25	WHYATT, H. G., A. M. Inst. C.E.	Borough Engineer, Great Grimsby.
1889 Feb. 9	WIKE, C. F., M. Inst. C.E. .. (*Member of Council.*)	City Surveyor, Sheffield.
1888 May 12	WILD, G. H.	Surveyor to the Urban District Council, Littleborough, near Manchester.
1896 Apr. 25	WILDING, J.	Surveyor to the Urban District Council, Runcorn.
1910 May 24	WILDS, R.	Engineer and Surveyor to the Urban District Council, Walton-on-Thames.
1905 June 22 R1911 Apr. 29	WILES, J. W.	1 Eltop Avenue, Errwood Road, Levenshulme, Manchester.
1912 Sept. 9	WILKES, J. E.	Town Planning Engineer, City Chambers, Dunfermline.
G1902 July 10 TAM1908 Feb. 29 T1911 July 29	*WILKINSON, F., A.M.Inst C.E.	Deputy Borough Engineer, Wimbledon, S.W.
1911 Sept. 23	*WILKINSON, Fred	Engineer and Surveyor, Urban District Council, Prestatyn.
1884 May 29 R1902 Nov. 8	WILKINSON, J. P., M. Inst. C.E.	301–304 Corn Exchange Chambers, Cathedral Street, Manchester.
1899 Mar. 25	WILKINSON, M. H.	Surveyor to the Urban District Council, Leyland.
1884 Oct. 9 R1885 June 6	WILLCOX, J. E., M. Inst. C.E.	63 Temple Row, Birmingham.
A1902 Mar. 22 T1909 July 17	WILLIAMS, H. B.	Borough Engineer, Workington.

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Date of Election and Transfer.		
A1902 July 10 TAM1909 Sept. 4 T1911 July 29	WILLIAMS, J.	Deputy Borough Surveyor, Hampstead.
1893 July 31	WILLIAMS, J. B.	Borough Surveyor, Daventry.
G1901 Dec. 7 TA1906 Dec. 15 TAM1911 July 29 T1912 Feb. 10	*WILLIAMS, J. H.	Deputy Borough Engineer, Todmorden.
A1906 Apr. 28 TAM1909 Mar. 27 T1911 July 29	WILLIAMS, S. G., A.M. Inst. C.E.	Resident Engineer, Water Department, Municipal Engineer's Office, Singapore, S.S.
1907 Mar. 2	WILLIAMS, T. T.	Surveyor to the Rural District Council, Swansea.
G1898 June 30 A1901 Dec. 7 T1908 Feb. 29	*WILLIS, E., A.M. Inst. C.E...	Surveyor to the Urban District Council, Chiswick.
1891 June 25	WILLMOT, J.	County Surveyor, Warwickshire. 6 Waterloo Street, Birmingham.
1904 Oct. 29	WILLOUGHBY, P. R. A., M.Inst. C.E.	Director of Public Works, Kingston, Jamaica, West Indies.
1898 June 30	WILSON, A.	County Surveyor, Dumbartonshire.
G1898 June 30 TA1901 Dec. 7 TAM1908 Sept. 5 T1911 July 29	*WILSON, F., A.M. Inst.C.E...	District Engineer, City Engineer's Office, Bristol.
1873 May 2 B1899 Feb. 25	WILSON, J.	Bankside, Bacup, Lancashire.
1912 Apr. 27	WILSON, J.	County Road Surveyor, East Berwickshire. Reston.
1884 May 29	*WILSON, J. B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cockermouth.
1912 Sept. 9	WILSON, R. E.	Engineer and Surveyor to the Urban District Council, Knaresborough.
1907 Apr. 27	WILSON, W.	Town Surveyor, Portadown, Ireland.
1880 Oct. 2	WINSHIP, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
1896 Feb. 22	WINTER, O. E., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Hampstead, N.W. *District Representative*, Metropolitan District.
1912 Jan. 13	WINTERBOTTOM, R. H. ..	Surveyor to the Urban District Council, Irlam, Lancs.
G1900 May 19 TA1902 Jan. 25 T1902 Nov. 8	*WOLFENDEN, B. J., A.M.Inst. C.E.	Borough Engineer, Bootle.
1894 Mar. 3	WOOD, F. J., A. M. Inst. C.E.	County Surveyor, Sussex East. Lewes.
AM1909 Feb. 27 T1911 July 29	*WOOD, H. C.	Surveyor, Rural District Council, Tadcaster.
1898 Apr. 23	WOOD, W. E.	Surveyor to the Urban District Council, Church.
1885 Oct. 3 B1903 Feb. 21	WOODBRIDGE, C. A.	Minafon, Hatch End, Middlesex.
1899 May 6	WOODWARD, F.	Surveyor to the Urban District Council, Stourbridge.

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Date of Election and Transfer.		
1897 July 8	*Worrall, E.	Surveyor to the Urban District Council, Stretford, Council Offices, Old Trafford.
1886 July 8	Worth, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
G1893 July 13 T1899 Oct. 21 R1904 Dec. 3	*Wright, J. A.	6 Unity Street, Bristol.
1910 Oct. 29	*Wright, W.	Borough Surveyor, Grantham.
G1906 June 28 T1908 Sept. 5	*Wrigley, G. E.	Engineer and Surveyor to the Urban District Council, Sowerby Bridge.
1892 May 28 R1908 Jan. 18	Wynne-Roberts, R.O., M.Inst. C.E	P.O. Box 65, Regina, Sask, Canada.
1895 Jan. 19	YABBICOM, T. H., M.Inst. C.E. (*Past President.*)	Consulting Engineer, Bristol Corporation, 63 Queen Square, Bristol.
G1891 Aug. 1 TA1901 Oct. 19 TAM1908 Sept. 5 T1911 July 29	*Yarwood, H...	Assistant Borough Surveyor, Rochdale.
G1892 July 11 T1892 Sept. 24	*Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
G1901 June 8 TA1902 Feb. 22 TAM1908 Sept. 5 T1911 July 29	*Yelland, T.	Deputy Borough Engineer, Bury, Lancs.
1912 Jan. 13	Yonemoto, S.	City Engineer, Tokio, Japan.
1894 June 21	York, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.
1904 Aug. 26	Young, C.	Burgh Surveyor, Coatbridge.
P1900 May 19	Young, J. .. .. (*Member of Council.*)	Burgh Surveyor, Ayr. *District Representative*, Scottish District.
1899 Dec. 16	Young, T.	Surveyor to the Rural District Council, Sunderland.
1900 May 19	Young, W. P...	Surveyor to the Rural District Council, Walsall.
1908 Sept. 5	Younger, J.	Engineer, P.W.D., Bulawayo, Rhodesia.

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ASSOCIATE MEMBERS.

[A.M.Inst.M.&Cy.E.]

* *Those Associate Members against whose name a star is placed have passed the examination and hold the Testamur of the Institution.*
R *signifies re-election under By-law* 6.
G *elected as Graduate* A *elected as Associate.*
TA *transferred to Associate.* TAM *transferred to Associate Member.*

Date of Election and Transfer.		
G1906 Apr. 28 TAM1911 July 29	ANDREWS, S. H.	Town Hall, Bermondsey, S.E.
A1901 Oct. 19 TAM1911 July 29	ASHBEE, W.	Divisional Surveyor, Middlesex C.C. Briarside, Hanwell, W.
1912 June 1	BALLARD, G. A.	Engineering Assistant to City Engineer, York.
G1905 June 22 TA1908 Sept. 5 TAM1911 July 29 R1912 Jan. 13	*BARKER, H. W., A.M. Inst. C.E.	City Engineer's Department, Council House, Birmingham.
A1909 Jan. 23 TAM1911 July 29	*BARLOW, A., A.M.Inst.C.E..	City Engineer and Surveyor, Town Hall, Ripon.
G1890 Mar. 29 TAM1911 July 29	*BAYLEY, G. H., A.M.Inst.C.E.	19 Cooper Street, Manchester.
G1906 Dec. 15 TA1908 Feb. 29 TAM1911 July 29	*BELL, G. H.	Borough Surveyor's Office, Swansea.
1912 Jan. 13	BENNETT, E. H.	Engineering Assistant, Borough Surveyor's Office, Derby.
1911 Sept. 23	*BENNETT, M. B.	Town Hall, Hove.
G1906 May 26 TAM1911 July 29	*BENTLEY, W.	468 St. Helens Road, Bolton, Lancs.
G1902 Mar. 22 TAM1911 July 29	*BERRINGTON, E. E. W.	Bank Buildings, Lichfield Street, Wolverhampton.
G1903 Dec. 12 TAM1911 July 29	*BIKER, W. J. E.	Baynes Lake, British Columbia.
G1900 June 16 TA1908 June 25 TAM1911 July 29	*BLAKEWAY-PHILLIPS, R. ..	City Engineer's Office, Westminster, S.W.
G1889 June 8 TAM1911 July 29	*BLIZARD, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton
A1903 Jan. 17 TAM1911 July 29	*BOOTH, E. W., A.M.Inst.C.E.	25 Cross Street, Manchester.
1911 Dec. 2	*BOSE, N. N.	Town Hall, Hyde.
G1892 Oct. 15 TAM1911 July 29	*BRADSHAW, J. B., A.M.Inst. C.E.	Royal Engineer's Office, Inner Lines, Chatham.
1912 Jan. 13	*BRAGGINS, A. D.	Assistant Surveyor, Urban District Council, Newquay.

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Date of Election and Transfer.		
1912 June 1	BRIGHT, C. D.	Assistant Surveyor, Saffron Walden.
A1903 July 25 TAM1911 July 29	*BROMLY, A., A.M. Inst. C.E.	Assistant Engineer, Town Hall, Croydon.
G1908 July 18 TA1909 Dec. 11 TAM1911 July 29	*BROTHERS, L. D.	Borough Surveyor's Office, Blackburn.
1912 Jan. 13	BROWN, A. W. D...	Engineering Assistant, Town Hall, Prahran, Victoria, Australia.
A1908 June 25 TAM1911 July 29	*BROWN, H. B. E., A.M.Inst. C.E.	Borough Engineer's Office, Northampton.
A1909 June 5 TAM1911 July 29	*BROWN, J. W. E.	Borough Surveyor's Office, Burnley.
G1889 July 4 TAM1911 July 29	*BRYANS, J. G., A.M.Inst.C.E.	277 Calle 25 de Mayo, Buenos Aires.
G1905 May 27 TA1908 July 18 TAM1911 July 29	*BULL, E. M., A.M.Inst.C.E.	Council Offices, Finchley.
G1899 June 29 TAM1911 July 29	*BURGESS, R. W.	Town Hall, Stratford, E.
G1905 June 29 TAM1911 July 29	*BUTLER, R.	21 Hazleton Avenue, Toronto, Canada.
GP1904 June 25 TAM1911 July 29	*BUTT, E. E. W.	Council Offices, Birmingham.
1912 Mar. 2	*CARDELL, J. E.	Assistant Road Surveyor, St. Ives, and Ramsay, Richmond House, St. Ives, Hunts.
A1904 Sept. 1 TAM1911 July 29	CARSON, W. H., Assoc. M. Inst. C.E.	Chief Engineer's Office, Department of Marine and Fisheries, Ottawa, Canada.
G1897 June 19 TAM1911 July 29	*CARTLEDGE, J. R.	Assistant Surveyor, District Council Offices, Barnes, S.W.
G1906 May 26 TAM1911 July 29	*CASTLE, J. H...	Engineering Assistant, Town Hall, Bedford.
G1908 June 25 TAM1911 July 29	*CHAPMAN, H. J.	Borough Surveyor's Office, The Wash, Hertford.
G1908 June 25 TAM1911 July 29	*CHARLES, J. A.	Borough Engineer's Office, Barrow-in-Furness.
A1909 Jan. 23 TAM1911 July 29	*CLARK, A.	Assistant Engineer, Rural District Council, Town Hall, Croydon.
G1904 Dec. 3 TAM1911 July 29	*CLARKE, R. E.	Public Offices, Arnold, Notts.
G1903 Dec. 12 TAM1911 July 29	*COCHRANE, J.	Water Engineer's Office, City Chambers, Glasgow.
1912 June 1	*COCKRILL, O. H.	Borough Surveyor's Office, Gt. Yarmouth.

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Date of Election and Transfer.		
1912 Feb. 10	COLE, A. V., A.M.Inst.C.E...	Borough Engineer's Office, Town Hall, Nelson.
G1911 Jan. 21 TAM1911 July 29	*COLES, A.	Bloomfield House, Peasedown, St. John, Bath.
A1904 Oct. 11 TAM1911 July 29	CONNOR, C.	c/o John Mowlem & Co., Grosvenor Wharf, S.W.
G1906 May 26 TA1908 Sept. 5 TAM1911 July 29	*CONWAY, F. J. K.	Pearl Assurance Buildings, St. John's Lane, Liverpool.
G1900 May 19 TA1901 Oct. 19 TAM1911 July 29	*COOMBS, C. A.	Irrigation Works, Trincomalee, Ceylon, India.
1912 Sept. 9	COOPER, L. A.	Engineer and Surveyor's Office, Town Hall, Chiswick.
G1906 Dec. 15 TAM1911 July 29	*COUZENS, R. H.	City Engineer's Office, York.
G1904 May 28 TAM1911 July 29	*COWLISHAW, H. H.	12 The Crescent, Westmead Road, Sutton, Surrey.
G1904 Jan. 23 TAM1911 July 29	*COX, C. E.	Hill View, Clent, near Stourbridge.
A1911 Mar. 4 TAM1911 July 29	*CRISWELL, H...	County Surveyor's Office, North Street, Horsham.
G1892 July 11 TAM1911 July 29	*CROSS, F. W., A.M. Inst. C.E.	Humberstone, Lichfield Road, Sutton Coldfield.
G1907 May 25 TA1908 Sept. 5 TAM1911 July 29	*CROSSLEY, H. B.	Works Assistant, Town Hall, Richmond.
G1903 June 6 TAM1911 July 29	*CUBITT, H. W.	227 Strand, W.C.
A1909 Dec. 11 TAM1911 July 29	*CUNLIFFE, I.	Surveyor's Office, Town Hall, Withington, Manchester.
G1911 June 10 TAM1911 July 29	*CURRIE, A. W.	Town Hall, Milton Road, Stoke Newington.
G1906 Jan. 20 TA1908 Apr. 25 TAM1911 July 29	*DARBY, H., A.M. Inst. C.E.	Town Hall, Ealing, W.
G1901 June 8 TAM1911 July 29	*DAVIDGE, W. R., Assoc. M. Inst. C.E.	District Surveyor, Lewisham Bank House, 95 High Street, Lewisham.
G1902 July 10 TAM1911 July 29	*DAWKINS, F.	Borough Surveyor's Office, Bournemouth.
G1903 Dec. 12 TA1905 May 27 TAM1911 July 29	*DEBNEY, W., A.M. Inst. C.E.	Borough Engineer's Office, Birkenhead.
G1907 Nov. 2 TAM1911 July 29	*DE COLVILLE, H. M.	Queen Anne Chambers, Westminster, S.W.
G1902 July 10 TAM1911 July 29	*DEELEY, G. P.	Moushall, Amblecote, Brierley Hill, Staffs.
A1904 Aug. 19 TAM1911 July 29	DE KRETSER, H. K.	The Star Fort, Matara, Ceylon.

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Date of Election and Transfer.		
1912 Mar. 2	*Dewhurst, J. T.	Assistant Engineer to Urban District Council, Audenshaw.
A1904 Aug. 12 TAM1911 July 29	Donald, R. B., A.M.Inst.C.E.	Chief Engineering Assistant, Borough Engineer's Office, Huddersfield.
1912 July 11	*Duckworth, W. Hy.	Council Offices, Watford, Herts.
G1910 June 16 TAM1911 July 29	*Durkin, F., A.M.Inst.C.E. ..	Engineering Assistant, Borough Surveyor's Office, West Hartlepool.
1912 Oct. 26	*Dyke, G.	Engineer's Office, Town Hall, Walsall.
G1906 May 26 TAM1911 July 29	*Eayrs, T. W., A.M.Inst.C.E.	City Engineer's Office, Council House, Birmingham.
A1909 Dec. 11 TAM1911 July 29	*Elliott, A. H.	Engineering Assistant to City Engineer, Nottingham.
G1886 Sept. 11 TAM1911 July 29	*Fenton, W. C.	10 Paradise Square, Sheffield.
G1900 June 16 TAM1911 July 29	*Fisher, R.	10 Fairlight Avenue, Harlesden, N.W.
G1910 Mar. 12 TAM1911 July 29	*Fletcher, R., A.M. Inst. C.E.	Assistant County Surveyor, Worcestershire County Council. "Stonall," West Road, Bromsgrove.
G1903 July 25 TAM1911 July 29	*Ford, J.	Lower House, Branscombe, Beer, S.O.
G1899 Oct. 21 TA1903 July 25 TAM1911 July 29	*Foster, H. H.	66 Boundaries Road, Balham, S.W.
A1910 Jan. 22 TAM1911 July 29	*Foster, H. P.	Chief Assistant, P.W. Engineer's Office, City Tramways, Leeds.
G1907 Dec. 14 TA1910 Jan. 22 TAM1911 July 29	*Furness, D.	City Surveyor's Office, Town Hall, Manchester.
A1909 Oct. 30 TAM1911 July 29	Gardner, J., A.M. Inst. C.E.	123 Boothferry Road, Goole.
G1899 June 10 TAM1911 July 29	*Gibson, W. S.	D'Arcy House, Hendon Lane, Finchley, N.
G1888 July 12 TAM1911 July 29	*Glass, S. N., A.M. Inst. C.E.	4 Western Gardens, Ealing Common, W.
G1906 Dec. 15 TA1908 Dec. 5 TAM1911 July 29	*Goldsmith, W. H.	Engineering Assistant, Town Hall, Hull.
G1908 Dec. 5 TAM1911 July 29	*Goodacre, E. J.	Municipal Offices, Nuneaton.

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Date of Election and Transfer.		
A1905 June 22 TAM1911 July 29	*Goode, W. J.	Divisional Surveyor, Shropshire. Wellington, Salop.
G1899 Dec. 16 TA1902 May 10 TAM1911 July 29	*Goodfellow, H., A.M.Inst. C.E.	Chief Engineering Assistant, Town Hall, Southport.
A1903 July 25 TAM1911 July 29	Gray, A. R.	Engineering Assistant, Council House, Birmingham.
G1906 May 26 TA1908 June 25 TAM1911 July 29	*Griffiths, H.	Borough Surveyor's Office, Crewe.
G1904 Dec. 3 TAM1911 July 29	*Grove, A.	1 Parkfield Terrace, Stourbridge.
G1905 June 22 TAM1911 July 29	*Gunson, E., A.M. Inst. C.E.	14 Furness Park Road, Barrow-in-Furness.
1912 Sept. 9	*Hammond, B. C.	County Road Surveyor's Department, Shire Hall, Worcester.
A1903 June 6 TAM1911 July 29	Harding, H. W.	Chief Engineering Assistant, City Engineer's Office, Bristol.
G1904 Jan. 23 TAM1911 July 29	*Harkness, J.	2 Barnes Terrace, Ayr.
G1908 May 23 TAM1911 July 29	*Harmer, E. F.	25 Mansion Road, Southampton.
G1906 Mar. 3 TAM1911 July 29	*Harrison, J.	355 Manchester Road, Burnley.
G1905 Oct. 28 TAM1911 July 29	*Hassall, J.	Town Hall, Sheffield.
G1907 Mar. 2 TAM1911 July 29	*Hazeltine, C. A., A.M.Inst. C.E.	Borough Engineer's Office, Stepney.
A1903 June 6 TAM1911 July 29	Heap, H., A. M. Inst. C.E. ..	16 Manor Avenue, Grimsby.
A1904 Aug. 26 TAM1911 July 29	Henderson, R. T.	City Engineer's Office, City Chambers, Glasgow.
G1907 Mar. 2 TA1908 Apr. 25 TAM1911 July 29	*Hodge, A. C.	City Surveyor's Office, Sheffield.
A1911 June 10 TAM1911 July 29	*Holden, L.	38 Victoria Park Road, Cardiff.
G1906 Mar. 3 TAM1911 July 29	*Holden, R. B.	Town Hall, Oldham.
1912 July 11	*Hopley, S. F.	Assistant Surveyor, Bedwellty Urban District Council, Glam.
G1904 Oct. 29 TAM1911 July 29	*Howell, H. H., A.M.Inst.C.E.	City Engineering Assistant, 63 Queen Square, Bristol.
G1909 Jan. 23 TAM1911 July 29	*Hughes, W. H.	Assistant Surveyor, Urban District Council, Maesteg, Glam.
G1907 Jan. 19 TAM1911 July 29	*Hunt, C. F., A.M. Inst. C.E.	74 Casewick Road, West Norwood, S.E.
1911 Dec. 2	*Hunt, J. C.	City Engineer's Office, 63 Queen Square, Bristol.

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Date of Election and Transfer.		
1912 Jan. 13	HUNTER, L. McL.	Assistant Engineer, City Engineer's Office, Ottawa, Canada.
A1910 Jan. 22 TAM1911 July 29	*HUBCOMB, H. F.	"Elmhurst," Baring Road, Beaconsfield.
G1899 June 10 TAM1911 July 29	*HUTCHINGS, W. A.	Springfield Brewery, Wolverhampton.
G1909 Dec. 11 TAM1911 July 29	*HUTSON, E. G.	c/o Messrs. Diggle and Son, Water Offices, Hind Hill Street, Heywood, Lancs.
A1909 June 5 TAM1911 July 29	*HYBART, F. R.	Engineer's Office, Urban District Council, Barry.
A1909 Dec. 11 TAM1911 July 29	*JARMAN, G. E.	c/o Valvoline Oil Company, Bombay, India.
G1905 Jan. 28 TAM1911 July 29	*JENNINGS, W.	Borough Engineer's Office, Leyton.
G1907 May 25 TA1908 Sept. 5 TAM1911 July 29	*JOHNSON, W. H.	City Surveyor's Office, Town Hall, Manchester.
1912 Jan. 13	*JONES, D. L.	Engineering Assistant, Borough Engineer's Office, Merthyr.
G1908 Dec. 5 TAM1911 July 29	*JONES, J. A.	Assistant Surveyor, Director of Works Dept., Admiralty. 72 Grafton Road, East Acton, W.
G1906 Dec. 15 TAM1911 July 22	*JONES, THOMAS	7 Grove Road, Wallasey.
A1909 July 17 TAM1911 July 29	*KEAY, E. N.	Borough Surveyor's Office, Eastbourne.
A1910 Dec. 10 TAM1911 July 29	KENT, C. G., A.M.Inst.C.E.	Resident Engineer, Hanslope Water Works. "Ravensworth," Maidstone Road, Rochester.
A1910 June 16 TAM1911 July 29	*KINDELL, F. P.	Engineering Assistant, Council Offices, Beckenham.
1912 July 11	*KIRBY, S. J.	Borough Engineer's Office, Batley.
G1903 June 25 TA1909 Feb. 27 TAM1911 July 29	*KNIGHT, R. R.	City Engineer's Office, 606 Givens Street, Toronto, Canada.
G1903 June 25 TAM1911 July 29	*KNOWLES, G. P., B.Sc. (Eng.) Lond., A.M. Inst. C.E.	39 Victoria Street, S.W.
G1905 Dec. 9 TAM1911 July 29	*LAKE, W. S.	P. W. D., Freetown, Sierra Leone, West Africa.
A1909 Feb. 27 TAM1911 July 29	LEEPER, L., B.Eng., A.M. Inst.C.E.	Assistant Engineer, Town Hall, Great Yarmouth.

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Date of Election and Transfer.		
A1911 Jan. 21 TAM1911 July 29	*Leney, C. W.	Highway Surveyor, Rural District Council, East Preston, West Sussex.
G1911 June 10 TAM1911 July 29	*Letheren, W. H.	Borough Engineer's Office, Northampton.
G1904 June 25 TA1910 Jan. 22 TAM1911 July 29	*Lewis, H. M.	Victoria Pier, Douglas, Isle of Man.
G1904 Dec. 3 TAM1911 July 29	*Line, H. W.	L.C.C., 19 Charing Cross Road, S.W.
1912 Oct. 26	*Lloyd, S. C.	Assistant to County Surveyor, West Sussex. Lewes.
G1907 May 25 TAM1911 July 29	*Loach, A. E.	Borough Engineer's Office, Northampton.
1911 Dec. 2	*Lockwood. G. O.	County Surveyor's Office. The Castle, Winchester.
A1909 Dec. 11 TAM1911 July 29	*Longstaff, J. T.	Engineer's Department, P.W.D., Hong Kong. 11A Conduit Rd., Hong Kong.
G1905 May 27 TAM1911 July 29	*McArd, A. J.	Borough Engineer's Office, Whitehaven.
G1900 Dec. 15 TAM1911 July 29	*MacDonald, K. G.	13 Charles Street, St. James's, S.W.
1912 Apr. 27	*McGlashan, J. S.	Town Hall, Wallasey.
A1904 Sept. 6 TAM1911 July 29	McInnes, D.	City Engineer's Office, Glasgow.
1912 Feb. 10	*Macmillan, R. S.	Burgh Surveyor's Office, Clydebank.
G1903 June 25 TAM1911 July 29	*Mann. E. E., B.Sc., A.M. Inst.C.E.	Borough Engineer's Office, Southampton.
A1904 Aug. 4 TAM1911 July 29	Marr, G. E.	District Offices, Hamilton.
G1903 Jan. 17 TAM1911 July 29	*Masters, W. H.	Glencairn, Arthur Road, Southampton.
G1905 Jan. 28 TA1907 June 20 TAM1911 July 29	*Mathew, H. B., A.M.Inst. C.E.	City Engineer's Office, Birmingham.
G1906 Dec. 15 TA1909 Mar. 27 TAM1911 July 29	*Matthews, R. H.	Chief Engineering Assistant, Urban District Council, Wood Green.
G1900 June 16 TAM1911 July 29	*Mattinson, H., A.M.Inst.C.E.	55 Piccadilly, Manchester.
A1909 Sept. 4 TAM1911 July 29	*Messent, E. J., A.M. Inst. C.E.	Resident Engineer, New Sewerage Works, Prittlewell, Southend.
G1901 Oct. 19 TAM1911 July 29	*Milnes, B.	Borough Engineer's Office, Birkenhead.
A1908 Oct. 24 TAM1911 July 29	Mitchell, J. G.	City Engineer's Office, Edinburgh.

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Date of Election and Transfer.		
G1898 Dec. 17 TA1901 Oct. 19 TAM1911 July 29	*Mitchell, G.	Water Engineer's Office, Aberdeen.
G1905 June 22 TAM1911 July 29	*Morgan, G. L.	Lan Wood, Pontypridd.
A1904 Sept. 19 TAM1911 July 29	Morrison, A. W.	City Engineer's Office, Edinburgh.
A1911 Mar. 4 TAM1911 July 29	*Moser, W.	294 Scotland Road, Nelson, Lancs.
G1902 Jan. 25 TAM1911 July 29	*Moss, W.	14 Heaketh Avenue, Didsbury, Manchester.
G1906 Jan. 20 TA1910 June 16 TAM1911 July 29	*Murray-Smith, A., A.M.Inst. C.E.	Municipal Offices, Cheltenham.
G1909 July 17 TAM1911 July 29	*Newcomen, T. G.	Engineer's Department, Council Offices, Church End, Finchley, N.
A1910 Jan. 22 TAM1911 July 29	*Newman, J. A.	Engineering Assistant, Birmingham Water Department.
G1906 Jan. 20 TAM1911 July 29	*Newsome, S. H.	67 Glencoe Road, Sheffield.
G1904 May 28 TAM1911 July 29	*Nicholls, R., A.M. Inst. C.E.	Borough Engineer's Office, Southampton.
G1896 June 25 TAM1911 July 29	*Nightingale, C. F.	"Endellion," Buchanan Road, Walsall.
G1905 Sept. 23 TAM1911 July 29	*Nighy, J.	Council Offices, Dartford.
1912 Apr. 27	*Norman, J. W.	General Engineering Assistant, Borough Surveyor's Office, Torquay.
G1910 Mar. 12 TAM1911 July 29	*Oddy, J. R. R.	Engineering Assistant to County Surveyor, West Riding. Bradford, Yorks.
G1907 June 20 TAM1911 July 29	*Ollevant, H. E.	Lyn Dene Villa, St. Lawrence Road, Tinsley, Sheffield.
G1895 June 27 TA1902 July 10 TAM1911 July 29	*Openshaw, J., A.M.Inst.C.E.	Engineering Assistant, Town Hall, Salford.
1912 June 1	*Osborne, H. J.	Council Offices, Rudolph Road, Bushey, Herts.
GP1905 Jan. 28 TAM1911 July 29	*Owen, J., A.M.Inst.C.E. ..	11 The Crescent, Sutton, Surrey.
G1899 Oct. 21 TAM1911 July 29	*Palmer, G. F.	c/o Messrs. Norton Griffiths and Co., St. Johns, New Brunswick, Canada.
1912 Mar. 2	*Panton, A. W., M.A., B.A.I., A.M.Inst.C.E.	Assistant Engineer, Sewerage Department, Municipal Buildings, Liverpool.

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Date of Election and Transfer.		
G1906 Dec. 15 TAM1911 July 29	*Parker, E.	Stretford District Council Offices, Old Trafford, Manchester.
1912 Feb. 10	*Payne, P. I.	1 Stanley Villas, Artillery Road, Guildford.
G1906 Dec. 15 TAM1911 July 29	*Peacock, J. L.	Sewage Works Contract, Newtownards, Co. Down.
G1906 June 28 TAM1911 July 29	*Pearce, W. H., A.M. Inst. C.E.	Borough Engineer's Office, Worthing.
G1904 June 25 TAM1911 July 29	*Pearson, T. G.	Town Hall, Barrow-in-Furness.
G1895 Jan. 19 TA1901 Oct. 19 TAM1911 July 29	*Perkins, J.	Engineering Assistant, Council House, Birmingham.
G1896 Feb. 22 TAM1911 July 29	*Perkins, T. L., A.M. Inst. C.E.	P. W. D., Hong Kong.
G1903 Feb. 21 TAM1911 July 29	*Perrott, E. S.	District Engineer, City Engineer's Office, Bristol.
G1902 July 10 TAM1911 July 29	*Phillips, R.	Southgate District Council Offices, Palmer's Green, N.
G1901 Aug. 24 TAM1911 July 29	*Pickin, W. H.	Engineer's Department, L.C.C., Spring Gardens, S.W.
A1909 Sept. 4 TAM1911 July 29	*Pollard, H. E.	Engineering Assistant, Shanghai Municipality.
G1906 Dec. 15 TAM1911 July 29 R1912 Jan. 13	*Pool, H...	Borough Surveyor's Office, Stoke-on-Trent.
G1909 Feb. 27 TAMP1911 July 29	*Price, A. J.	Borough Surveyor's Office, Eccles.
1912 Feb. 10	Pryde, J.	Assistant County Road Surveyor, Queen Anne Street, Dunfermline.
G1898 June 30 TAM1911 July 29	*Quick, A. H., Assoc. M. Inst. C.E.	"Inverness," Malvern Road, Thornton Heath.
G1900 Dec. 15 TAM1911 July 29	*Rawstron, C. O.	Surveyor's Office, Rural District Council, Lichfield, Staffs.
1912 Jan. 13	Rean, W. H.	Engineering Assistant, Borough Surveyor's Office, Dover.
G1902 Nov. 8 TAM1911 July 29	*Redford, W. T.	City Surveyor's Office, Town Hall Manchester.
A1910 June 16 TAM1911 July 29	Reed, F.	Assistant Engineer, L.C.C. Trams, 51 Hotham Road, Putney.
A1904 Aug. 31 TAM1911 July 29	Reid, M...	Burgh Engineer's Office, Paisley.
A1911 June 10 TAM1911 July 29	*Richardson, T. C., A.M. Inst. C.E.	N69 Rua de Santa Luzia, Rio de Janiero, S. America.

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Date of Election and Transfer.			
G1904 May 28 TA1908 Sept. 5 TAM1911 July 29	*Richmond, W. S., A.M.Inst. C.E.		Engineering Assistant, Town Hall, Hornsey.
1912 Mar. 2	Rimell, H. C.		Senior Engineering Assistant, Corporation Water Works, Cardiff.
G1908 July 18 TAM1911 July 29	*Roberts, L. G.		27 Salford Road, Telford Park, Streatham Hill, S.W.
G1900 Feb. 10 TAM1911 July 29	*Ross, D.		"Balnagowan," Charleston Road, Eastbourne.
1911 Dec. 2	*Rothwell, J. T.		Town Hall, Barrow-in-Furness.
1911 Sept. 23	*Rubie, W. C.		Council House, Birmingham.
A1910 May 24 TAM1911 July 29	*Sanderson, H., A.M.Inst.C.E.		Borough Engineer's Office, Keighley.
G1904 May 28 TAM1911 July 29	*Schlund, W. T. S.		14 Vernham Road, Plumstead Common, S.E.
1912 July 11	*Scott, A. D.		Borough Engineer's Office, Barrow-in-Furness.
A1910 Jan. 22 TAM1911 July 29	*Senior, S. M.		Engineering Assistant, City Engineer's Office, York.
A1911 Mar. 4 TAM1911 July 29	*Shellard, I. F.		Borough Surveyor's Office, Newport, Mon.
G1909 Dec. 11 TAM1911 July 29	*Siddons, B. L.		"Carson Hall," Kent Street, Sydney, N.S.W.
G1899 June 29 TAM1911 July 29	*Simms, F.		Town Hall, Sheffield.
G1910 June 16 TAM1911 July 29	*Skillman, J.		Surveyor's Department, Public Offices, Teddington.
1911 Sept. 23	Smith, P. H. A.		Town Hall, Leicester.
G1906 May 26 TAM1911 July 29	*Smith, W. B.		Surveyor's Department, District Council Offices, Surbiton.
G1908 Dec. 5 TAM1911 July 29	*Staley, F. G.		Town Hall, Bedford.
G1899 June 29 TA1910 Mar. 12 TAM1911 July 29	*Stanton, F. W. S., A.M.Inst. C.E.		Consulting Engineer, Sheppey Rural District Council, 10 The Paddock, Chatham.
G1907 June 20 TAM1911 July 29	*Stanyer, F.		Fullford House, Lichfield.
A1911 July 5 TAM1911 July 29	*Statham, A. P.		Town Hall, Salford.
A1904 Aug. 22 TAM1911 July 29	Stephen, T. M.		District Offices, Hamilton.
A1904 Apr. 30 TAM1911 July 29	Story, G. E.		14 Park Road North, Bedford.
G1911 June 10 TAM1911 July 29	*Sturgess, G.		Engineer's Office, Town Hall, Chelsea.
A1911 June 10 TAM1911 July 29	*Stuttle, B. W.		Borough Engineer's Office, Stepney.

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Date of Election and Transfer.		
G1906 Mar. 3 TAM1911 July 29	*Sutcliffe, H.	25 Rosehill Road, Burnley.
1912 Feb. 10	*Swindells, H. C.	Engineering Assistant, District Surveyor's Office, Withington, Manchester.
1912 Jan. 13	Taylor, A. S. V., A.M.Inst. C.E.	Surveyor's Office, Rural District Council, Neath.
G1900 Dec. 15 TAM1911 July 29	*Taylor, H. T.	3 North Terrace, Gt. Meols, Hoylake, Cheshire.
A1910 Mar. 12 TAM1911 July 29	*Taylor, R.	Engineering Assistant to Borough Surveyor, Haslingden.
A1908 Oct. 24 TAM1911 July 29	*Teasdale, G. W.	9 Persehouse Street, Walsall, Staffs.
G1907 Sept. 7 TAM1911 July 29	*Thomas, E.	Works Department, Admiralty, Whitehall, S.W.
A1910 Apr. 23 TAM1911 July 29	Thomas, W. N.	21 Corporation Oaks, Nottingham.
1911 Dec. 2	Thompson, J. B.	Public Offices, Southall, Middlesex.
G1911 June 10 TAM1911 July 29 E1912 Jan. 13	*Thompson, W. H.	City Engineer's Department, Council House, Birmingham.
G1907 Sept. 7 TA1908 Sept. 5 TAM1911 July 29 E1912 Jan. 13	*Tomey, N. G.	City Engineer's Department, Council House, Birmingham.
G1905 Sept. 23 TAM1911 July 29	*Tonge, J. A.	125 Nottingham Road, Mansfield.
G1909 July 17 TAM1911 July 29	*Tonks, H. J.	Heath Villa, Willenhall.
G1908 Sept. 5 TAM1911 July 29	*Trodd, J. W...	Engineer's Department, Town Hall, Leyton, E.
G1904 May 28 TAM1911 July 29	*Tulley, G. W.	3 Parliament Square, Edinburgh.
1912 Apr. 27	Turner, E. W.	Assistant to Surveyor of Highways, Town Hall, Sheffield.
G1910 Jan. 22 TAM1911 July 29	*Turner, S. G.	23 Earls Court Gardens, S.W
1912 Feb. 10	*Vanstone, C. D. H.	Palace Chambers, Paignton.
G1905 May 27 TAM1911 July 29	*Vernon, A.	Town Hall, Upper Street, Islington.
A1909 June 5 TAM1911 July 29	*Wait, O. H.	Engineer's Office, P.W.D., Penang, S.S.
G1888 Jan. 14 TAM1911 July 29	*Ward, F. D., A. M. Inst. C.E.	42 Field Road, New Brighton.
G1897 June 19 TA1908 Oct. 24 TAM1911 July 29	*Webb, F.	Assistant to Borough Surveyor, Chelsea.

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Date of Election and Transfer.		
G1911 July 5 TAM1911 July 29	*Webb, O. S.	Borough Engineer's Office, Newbury.
G1898 Jan. 15 TAM1911 July 29	*Wells, F. B., Assoc. M. Inst. C.E.	c/o The Great Southern Railway Co., Buenos Aires.
G1902 Sept. 6 TAM1911 July 29	*West, A. S., A.M.Inst.C.E...	Water Engineer, Waterworks Offices, 7 Haywra Crescent, Harrogate.
G1902 July 10 TA1905 Jan. 28 TAM1911 July 29	*Whitaker, G. H., A.M. Inst. C.E.	Chief Assistant, Borough Engineer's Office, Sunderland.
G1901 June 8 TAM1911 July 29	*Whiteford, E. H., M. Inst. C.E.	Resident Engineer, Derwent Reservoir Works, Derwent, via Sheffield.
G1902 Nov. 8 TA1904 Feb. 27 TAM1911 July 29	*Wibberley, J., A.M.Inst.C.E.	Engineering Assistant, Municipal Offices, Plymouth.
G1901 Aug. 24 TA1907 Nov. 2 TAM1911 July 29	*Wilkinson, H. F., A.M.Inst. C.E.	Senior Engineering Assistant, Urban District Council, Tottenham.
G1901 June 27 TAM1911 July 29	*Willett, A. J.	18 Castledine Road, Anerley, S.E.
G1895 June 27 TAM1911 July 29	*Williams, D. S.	City Chambers, 47 Queen's Road, Cardiff.
G1910 May 24 TAM1911 July 29	*Wintle, A.	33 Strawberry Hill Road, Twickenham.
A1910 Mar. 12 TAM1911 July 29	Wishlade, T. W., A. M. Inst. C.E.	Borough Surveyor's Office, Town Hall, Bermondsey, S.E.
A1908 Sept. 5 TAM1911 July 29	Wood, H., A.M.Inst.C.E. ..	Chief Sewerage Assistant, City Engineer's Office, Norwich.
A1910 Dec. 10 TAM1911 July 29	*Woodhall, P. C.	Borough Surveyor, Blandford, Dorset.
G1900 July 19 TAM1911 July 29	*Wrack, W. P.	117 High Street, Poplar, E.
G1904 June 25 TAM1911 July 29	*Wright, F. W.	Resident Engineer's Office, Heanor Road, Ilkeston, Derbyshire.
G1906 May 26 TAM1911 July 29	*Wright, W., A.M.Inst.C.E...	Assistant Surveyor, Municipal Offices, Sutton, Surrey.

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TOPOGRAPHICAL LIST

OF

MEMBERS AND ASSOCIATE MEMBERS.

A. *signifies*	ABROAD.	S. *signifies*	SOUTHERN DISTRICT.
Af. „	AFRICAN DISTRICT.	S.W. „	SOUTH-WESTERN DIST.
E. „	EASTERN DISTRICT.	Ind. „	INDIAN DISTRICT.
N.E. „	NORTH-EASTERN DISTRICT.	I. „	IRISH DISTRICT.
N.W. „	NORTH-WESTERN DISTRICT.	Met. „	METROPOLITAN DISTRICT.
W.M. „	WEST MIDLAND DISTRICT.	Scot. „	SCOTTISH DISTRICT.
E.M. „	EAST MIDLAND DISTRICT.	W.N. „	WELSH DISTRICT (North).
S.E. „	SOUTH-EASTERN DISTRICT.	W.S. „	„ „ (South).

TOWN.	DISTRICT.		NAME.
ABERDEEN	Scot.	M	W. Dyack.
ABERDEEN	Scot.	M	J. Gordon.
ABERDEEN	Scot.	AM	G. Mitchell.
ABERDEENSHIRE (County)	Scot.	M	G. Calvert.
ABERGAVENNY	W.S.	M	F. Mansfield.
ABERGELE	W.N.	M	M. R. Jones.
ABERSYCHAN	W.S.	M	E. Whitwell.
ABINGDON	S.	M	G. Winship.
ACCRINGTON	N.W.	M	W. J. Newton.
ACTON	E.	M	F. Sadler.
ACTON	E.	AM	J. A. Jones.
AIRDRIE	Scot.	M	H. Inglis.
ALBERTA, CANADA	A.	AM	G. B. Underhill.
ALDERSHOT	S.	M	F. C. Uren.
ALEXANDRIA	A.	M	D. E. Lloyd-Davies.
ALEXANDRIA	A.	M	S. S. Davson.
ALTON	S.	M	G. B. Hartfree.
ALTON (Rural)	S.	M	C. W. Maudsley.
ALTRINCHAM	N.W.	M	H. E. Brown.
AMARU, CUMNOCK, N.S. WALES	A.	M	T. O. Cudbird.
ANDOVER	S.	M	R. W. Knapp.
ANERLEY	S.E.	AM	A. J. Willett.
ANNFIELD PLAIN	N.E.	M	T. J. Trowsdale.
ANTRIM (County)	I.	M	J. H. Brett.
ANURADAPURA, CEYLON	Ind.	M	A. H. Nathanielsz.
ARBROATH	Scot.	M	P. C. Smith.
ARBROATH	Scot.	M	D. Maxwell.
ARGYLLSHIRE (County)	Scot.	M	M. B. McBeth.
ARMAGH (County)	I.	M	R. H. Dorman.
ARMAGH	I.	M	J. C. Boyle.
ARNOLD	E.M.	AM	R. E. Clarke.
ASHBY-DE-LA-ZOUCH (Rural)	E.M.	M	S. Turner.
ASHFIELD, NEW SOUTH WALES	A.	M	J. D. Goodwin.
ASHFORD	S.E.	M	W. Terrill.
ASHFORD (Rural)	S.E.	M	A. Sims.
ASHTON-ON-MERSEY	N.W.	M	F. Hutton.
ASHTON-UNDER-LYNE	N.W.	M	J. T. Earnshaw.

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TOWN.	DISTRICT.		NAME.
Ashton-under-Lyne	N.W.	M	F. J. Dixon.
Ashton-under-Lyne	N.W.	M	J. Rowbottom.
Atherstone (Rural)	W.M.	M	H. J. Coleby.
Auckland, New Zealand	A.	M	W. E. Bush.
Audenshaw	N.W.	M	W. Clough.
Audenshaw	N.W.	AM	J. T. Dewhurst.
Axminster	S.W.	M	G. A. Millard.
Aylesbury	E.	M	W. H. Taylor.
Aylesbury (Rural)	E.	M	R. T. Stewart.
Ayr	Scot.	M	J. Young.
Ayrshire (County)	Scot.	M	A. Stevenson.
Ayrshire South (County) ..	Scot.	M	R. Moir.
Bacup	N.W.	M	W. H. Elce.
Bacup	N.W.	M	J. Wilson.
Balby with Hexthorpe	N.E.	M	G. Gledhill.
Balham	Met.	AM	H. H. Foster.
Ballymena	I.	M	H. O'Hara.
Banbury	S.	M	N. H. Dawson.
Barking	E.	M	C. F. Dawson.
Barking	E.	M	C. J. Dawson.
Barmouth	W.N.	M	T. R. Parry.
Barnes	S.E.	M	G. B. Tomes.
Barnes	S.E.	AM	J. R. Cartledge.
Barnstaple	S.W.	M	E. Y. Saunders.
Barrow-in-Furness	N.W.	M	A. Race.
Barrow-in-Furness	N.W.	M	W. C. Persey.
Barrow-in-Furness	N.W.	AM	J. A. Charles.
Barrow-in-Furness	N.W.	AM	E. Gunson.
Barrow-in-Furness	N.W.	AM	T. G. Pearson.
Barrow-in-Furness	N.W.	AM	J. T. Rothwell.
Barrow-in-Furness	N.W.	AM	A. D. Scott.
Barrowford	N.W.	M	G. W. Hewes.
Barry	W.S.	M	J. C. Pardoe.
Barry	W.S.	M	E. R. Hinchsliff.
Barry	W.S.	AM	F. R. Hybart.
Barton-on-Irwell (Rural)	N.W.	M	A. H. Mountain.
Basford (Rural)	E.M.	M	S. Maylan.
Basford (Rural) (Highways) ..	E.M.	M	G. W. Hawley.
Basingstoke	S.	M	F. R. Phipps.
Bath	S.W.	AM	A. Coles.
Batley	N.E.	M	H. L. Hall.
Batley	N.E.	AM	S. J. Kirby.
Battersea	Met.	M	T. W. A. Hayward.
Battersea	Met.	M	W. J. Dresden.
Battersea	Met.	M	H. A. White.
Baynes Lake, British Columbia	A.	AM	W. J. E. Biker.
Bracknefield	E.	AM	H. F. Hurcomb.
Brockles	E.	M	C. L. Hamby.
Beckenham	S.E.	M	J. A. Angell.
Beckenham	S.E.	M	H. S. Best.

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TOWN.	DISTRICT.		NAME.
Beckenham	S.E.	AM	F. P. Kindell.
Bedford (County)	E.	M	W. H. Leete.
Bedford	E.	M	N. Greenshields.
Bedford	E.	AM	J. H. Castle.
Bedford	E.	AM	F. G. Staley.
Bedford	E.	AM	G. E. Story.
Bedwellty	W.S.	M	D. H. Price.
Bedwellty	W.S.	AM	S. F. Hopley.
Beer	S.W.	AM	J. Ford.
Belfast	I.	M	H. A. Cutler.
Belfast	I.	M	H. F. Gullan.
Belper	E.M.	M	T. Fenn.
Belper (Rural)	E.M.	M	R. C. Cordon.
Benoni, Transvaal	Af.	M	D. P. Howells.
Benwell and Fenham	N.E.	M	W. P. Pattison.
Berkhamsted (Rural)	E.	M	H. N. Hedges.
Berkshire (County)	S.	M	J. F. Hawkins.
Bermondsey	Met.	M	R. J. Angel.
Bermondsey	Met.	AM	T. W. Wishlade.
Bermondsey	Met.	AM	S. H. Andrews.
Berwick East (County)	Scot.	M	J. Wilson.
Berwick-on-Tweed	N.E.	M	R. Dickinson.
Bethnal Green	Met.	M	A. E. Darby.
Beverley	N.E.	M	J. G. Smith.
Beverley (Rural)	N.E.	M	E. Picker.
Bexhill	S.E.	M	G. Ball.
Bexhill	S.E.	AM	J. R. Fothergill.
Bexley	S.E.	M	W. T. Howse.
Bickley, Kent	S.E.	M	A. Creer.
Biddulph	W.M.	M	S. Gibson.
Biggleswade	E.	M	T. Cockrill.
Biggleswade (Rural)	E.	M	J. O. Jones.
Billericay (Rural)	E.	M	R. J. W. Layland.
Bingley	N.E.	M	H. Bottomley.
Birkdale	N.W.	M	J. Mitchell.
Birkdale	N.W.	M	W. Nuttall.
Birkenhead	N.W.	M	C. Brownridge.
Birkenhead	N.W.	M	R. W. Johnston.
Birkenhead	N.W.	AM	W. Debney.
Birkenhead	N.W.	AM	B. Milnes.
Birmingham	W.M.	M	H. E. Stilgoe.
Birmingham (Sewers and Rivers)	W.M.	M	E. B. Savage.
Birmingham	W.M.	M	J. D. Watson.
Birmingham	W.M.	M	J. E. Willcox.
Birmingham	W.M.	M	H. Richardson.
Birmingham	W.M.	M	J. E. Parr.
Birmingham	W.M.	M	A. S. Parsons.
Birmingham	W.M.	M	W. E. Ballard.
Birmingham	W.M.	M	C. E. Lawton.
Birmingham	W.M.	AM	H. W. Barker.
Birmingham	W.M.	AM	W. H. Thompson.
Birmingham	W.M.	AM	N. G. Tomey.

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TOWN.	DISTRICT.		NAME.
Birmingham	W.M.	AM	E. E. W. Butt.
Birmingham	W.M.	AM	T. W. Eayrs.
Birmingham	W.M.	AM	A. R. Gray.
Birmingham	W.M.	AM	H. B. Mathew.
Birmingham	W.M.	AM	J. A. Newman.
Birmingham	W.M.	AM	J. Perkins.
Birmingham	W.M.	AM	W. C. Rubie.
Birstall	N.E.	M	T. H. Hailstone.
Bishop's Stortford	E.	M	R. S. Scott.
Bispham with Norbreck	N.W.	M	T. Harrop.
Blackburn	N.W.	M	W. Stubbs.
Blackburn	N.W.	M	W. A. Foster.
Blackburn	N.W.	AM	L. D. Brothers.
Blackpool	N.W.	M	J. S. Brodie.
Blackpool (Water)	N.W.	M	J. Cook.
Blackwell (Rural)	E.M.	M	H. Silcock.
Blaenavon	W.S.	M	E. W. Edwards.
Blandford	S.W.	AM	P. C. Woodhall.
Blyth	N.E.	M	R. Grieves.
Blyth and Cuckney (Rural)	E.M.	M	F. Hopkinson.
Bognor	S.E.	M	O. A. Bridges.
Bolton	N.W.	M	E. L. Morgan.
Bolton	N.W.	M	J. Proctor.
Bolton	N.W.	AM	W. Bentley.
Bombay	Ind.	M	J. Hall.
Bombay (Water)	Ind.	M	H. J. T. Smith.
Bombay	Ind.	AM	G. E. Jarman.
Bo'ness	Scot.	M	J. Louden.
Bootle	N.W.	M	B. J. Wolfenden.
Bootle	N.W.	M	A. T. Gooseman.
Boston	E.M.	M	G. E. Clarke.
Bourne (Rural) (Highways)	E.M.	M	T. Lake.
Bournemouth	S.	M	F. W. Lacey.
Bournemouth	S.	M	F. P. Dolamore.
Bournemouth	S.	M	W. H. Mackenzie.
Bournemouth	S.	AM	F. Dawkins.
Bradford	N.E.	M	J. H. Cox.
Bradford	N.E.	M	R. Armistead.
Bradford	N.E.	M	J. W. Foster.
Bradford-on-Avon	S.	M	R. B. Lees.
Brecon	W.S.	M	H. Ll. Griffiths.
Brecknshire (County)	W.S.	M	W. L. Harpur.
Brentford	E.	M	J. W. Croxford.
Brentford	E.	M	N. Parr.
Brentwood	E.	M	A. J. Meeson.
Bridgwater	S.W.	M	F. Parr.
Bridgwater (Rural)	S.W.	M	W. A. Collins.
Bridlington	N.E.	M	E. R. Matthews.
Bridlington (Rural)	N.E.	M	S. Dyer.
Brierfield	N.W.	M	B. Halstead.
Brierley Hill	W.M.	M	J. L. Harpur.
Brierley Hill	W.M.	AM	G. P. Deeley.

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TOWN.	DISTRICT.		NAME.
Brighouse	N.E.	M	S. S. Haywood.
Brighton (Water)	S.E.	M	J. Johnston.
Brisbane	A.	M	T. Kirk.
Brisbane	A.	M	W. E. Irving.
Bristol	S.	M	T. H. Yabbicom.
Bristol	S.	M	W. H. G. Kieser.
Bristol	S.	M	E. W. Lashmore.
Bristol	S.	M	F. Wilson.
Bristol	S.	M	A. P. I. Cotterell.
Bristol	S.	M	A. J. Saise.
Bristol	S.	M	J. A. Wright.
Bristol	S.	M	A. H. Claypoole.
Bristol	S.	M	L. S. McKenzie.
Bristol	S.	M	W. L. F. Palmer.
Bristol	S.	AM	H. W. Harding.
Bristol	S.	AM	H. H. Howell.
Bristol	S.	AM	E. S. Perrott.
Bristol	S.	AM	J. C. Hunt.
British Uganda	Af.	M	J. D. Milner.
Briton Ferry	W.S.	M	H. A. Clarke.
Brixton	Met.	M	J. P. Norrington.
Bromyard	W.M.	M	J. D. Barrs.
Broughty Ferry	Scot.	M	T. K. Roddan.
Brownhills	W.M.	M	J. H. Shaw.
Brynmawr	W.S.	M	J. J. Quirk.
Buckhurst Hill	E.	M	H. Tooley.
Buckingham (County)	E.	M	R. J. Thomas.
Buenos Aires	A.	AM	J. G. Bryans.
Buenos Aires	A.	AM	F. B. Wells.
Buenos Aires	A.	AM	L. G. Duncan.
Bulawayo, Rhodesia	Af.	M	J. Younger.
Burnham	S.W.	M	W. H. Chowins.
Burnley	N.W.	M	G. H. Pickles.
Burnley	N.W.	M	J. P. Greenwood.
Burnley	N.W.	M	J. T. Landless.
Burnley (Rural)	N.W.	M	H. Pritchard.
Burnley	N.W.	AM	J. W. E. Brown.
Burnley	N.W.	AM	J. Harrison.
Burnley	N.W.	AM	H. Sutcliffe.
Bursledm	W.M.	M	F. Bettany.
Bursledm	W.M.	M	F. P. Sissons.
Burton-on-Trent	W.M.	M	G. T. Lynam.
Burton-on-Trent	W.M.	M	W. Thompson.
Bury	N.W.	M	T. Yelland.
Bury	N.W.	M	J. Cartwright.
Bury	N.W.	M	J. A. Settle.
Bushey	E.	M	E. E. Ryder.
Bushey	E.	AM	H. J. Osborne.
Buxton	E.M.	M	F. Langley.

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TOWN.	DISTRICT.		NAME.
Caerphilly	W.S.	M	A. O. Harpur.
Cairo (P.W.D.)	Af.	M	C. C. James.
Cairo	Af.	M	S. F. L. Fox.
Calcutta	Ind.	M	J. Maden.
Camberwell	Met.	M	F. J. Slater.
Camborne	S.W.	M	C. D. Bell,
Cambridge (County)	E.	M	J. E. Blackwall.
Cambridge	E.	M	J. Julian.
Cannock	W.M.	M	R. Blanchard.
Canterbury	S.E.	M	A. C. Turley.
Cape Town	Af.	M	T. W. Stainthorpe.
Cape Town	Af.	M	T. W. Cairncross.
Cape Town	Af.	M	A. E. Snape.
Cardiff	W.S.	M	W. Harpur.
Cardiff (Water)	W.S.	M	C. H. Priestley.
Cardiff	W.S.	M	W. H. Haigh.
Cardiff	W.S.	AM	L. Holden.
Cardiff	W.S.	AM	D. S. Williams.
Cardiff (Water)	W.S.	AM	H. C. Rimmell.
Carlisle	N.W.	M	H. C. Marks.
Carlisle	N.W.	M	W. W. R. Harlow.
Carlton	E.M.	M	J. C. Haller.
Carnarvon	W.N.	M	E. Hall.
Carnarvonshire (County)	W.N.	M	E. Evans.
Carnoustie	Scot.	M	P. Sinclair.
Castleford	N.E.	M	W. Green.
Chadderton	N.W.	M	L. M. Hindle.
Chapel-en-le-Frith	N.W.	M	H. T. Hughes.
Chard (Rural)	S.W.	M	R. Stephens.
Chatham	S.E.	M	C. Day.
Chatham	S.E.	M	R. L. Honey.
Chatham	S.E.	AM	J. B. Bradshaw.
Cheadle	W M.	M	T. Bibbey.
Chelmsford	E.	M	P. T. Harrison.
Chelmsford (Rural)	E.	M	J. Dewhirst.
Chelsea	Met.	M	T. W. E. Higgens.
Chelsea	Met.	M	W. R. Manning.
Chelsea	Met.	AM	G. Sturgess.
Chelsea	Met.	AM	F. Webb.
Cheltenham	S.	M	J. S. Pickering.
Cheltenham	S.	M	W. H. J. White.
Cheltenham	S.	AM	A. Murray-Smith.
Cheriton	S.E.	M	A. O. Sherren.
Chesham	E.	M	P. C. Dormer.
Cheshire (County)	N.W.	M	H. F. Bull.
Chesthunt	E.	M	J. E. Sharpe.
Chester	N.W.	M	W. H. M. Jones.
Chester	N.W.	M	I. M. Jones.
Chesterfield	E.M.	M	V. Smith.
Chesterton	E.	M	J. D. Bland.
Chesterton (Rural)	E.	M	J. Dunn.
Chippenham	S.	M	A. E. Adams.

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TOWN.	DISTRICT.		NAME.
Chippenham (Rural)	S.	M	A. H. Lapham.
Chiswick	E.	M	E. Willis.
Chiswick	E.	AM	L. A. Cooper.
Chittagong, Eastern Bengal ..	Ind.	M	A. F. Henderson.
Chorley	N.W.	M	W. Leigh.
Christchurch	S.	M	H. J. Farmer.
Church	N.W.	M	W. E. Wood.
Clayton-le-Moors	N.W.	M	A. Dodgeon.
Cleckheaton	N.E.	M	C. Lund.
Cleethorpes	E.M.	M	E. Rushton.
Cleethorpes	E.M.	M	C. H. Waithman.
Clent	W.M.	AM	C. E. Cox.
Clutton (Rural)	S.	M	W. J. Goode.
Clydebank	Scot.	AM	R. S. MacMillan.
Coalville	E.M.	M	L. L. Baldwin.
Coatbridge	Scot.	M	C. Young.
Cockermouth (Rural)	N.W.	M	J. B. Wilson.
Cockfosters	E.	M	W. H. Savage.
Colchester	E.	M	H. Goodyear.
Colchester	E.	M	E. A. Slater
Colne	N.W.	M	T. H. Hartley.
Colombo, Ceylon	Ind.	M	F. A. Cooper.
Colombo, Ceylon	Ind.	M	R. Skelton.
Colombo, Ceylon	Ind.	M	C. L. Cox.
Colombo, Ceylon	Ind.	M	H. B. Lees.
Colombo, Ceylon	Ind.	M	C. H. Kilmister
Colwyn Bay	W.N.	M	W. Jones.
Colwyn Bay	W.N.	M	W. J. Dunning.
Congleton	N.W.	M	R. Burslam.
Congleton	N.W.	M	J. R. Walters.
Consett	N.E.	M	W. S. Shell.
Conway (Rural)	W.N.	M	T. B. Farrington.
Cork, West (County)	I.	M	R. W. F. Longfield.
Cork	I.	M	J. F. Delany.
Cornwall (County)	S.W.	M	A. E. Brookes.
Cornwall Central (County) ..	S.W.	M	W. J. Merrett.
Cornwall (County)	S.W.	M	G. Palmer.
Cowes	S.	M	J. W. Webster.
Cowes	S.	M	D. J. Brown.
Crewe	N.W.	M	G. Eaton-Shore.
Crewe	N.W.	AM	H. Griffiths.
Crieff	Scot.	M	A. W. Allison.
Cromer	E.	M	R. Croome.
Croydon	S.E.	M	G. F. Carter.
Croydon (Highways)	S.E.	M	E. F. Morgan.
Croydon (Rural)	S.E.	M	R. M. Chart.
Croydon (Rural) (Highways) ..	S.E.	M	J. S. Killick.
Croydon (Rural)	S.E.	M	R. Chart.
Croydon	S.E.	AM	A. Bromly.
Croydon (Rural)	S.E.	AM	A. Clark.
Cupar (County)	Scot.	M	T. Aitken.

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TOWN.	DISTRICT.		NAME.
Dartford	S.E.	M	T. E. Tiffen.
Dartford	S.E.	AM	J. Nighy.
Dartmouth (Water)	S.W.	M	W. G. Lane.
Darwen	N.W.	M	R. W. Smith-Saville.
Daventry	E.	M	J. B. Williams.
Dawlish (Water)	S.W.	M	S. F. C. Churchward.
Deal	S.E.	M	T. C. Golder.
Delhi	Ind.	M	T. Salkield.
Deptford	Met.	M	J. Sutcliffe.
Derby (County)	E.M.	M	J. W. Horton.
Derby (County)	E.M.	M	A. J. Metcalfe.
Derby	E.M.	M	J. Ward.
Derby	E.M.	M	C. A. Clews.
Derby	E.M.	AM	E. H. Bennett.
Derwent	N.E.	AM	E. H. Whiteford.
Devon (County)	S.W.	M	S. Ingram.
Devon (County)	S.W.	M	W. P. Robinson.
Dewsbury	N.E.	M	H. Dearden.
Dewsbury	N.E.	M	S. Matthew.
Didsbury	N.W.	AM	W. Moss.
Doncaster	N.E.	M	F. O. Kirby.
Doncaster (Rural)	N.E.	M	W. R. Crabtree.
Dorking	S.E.	M	W. A. Clegg.
Dorking (Rural)	S.E.	M	W. Rapley.
Douglas, Isle of Man	N.W.	M	F. Cottle
Douglas, Isle of Man (Highways)	N.W.	M	W. R. Kay.
Douglas, Isle of Man	N.W.	M	A. D. Barron.
Douglas, Isle of Man	N.W.	AM	H. M. Lewis.
Dover	S.E.	M	W. C. Hawke.
Dover	S.E.	AM	W. H. Rean.
Down (County)	I.	M	J. Heron.
Driffield (Rural)	N.E.	M	T. C. Beaumont.
Droylsden	N.W.	M	C. Hall.
Dublin (County)	I.	M	W. Collen.
Dublin	I.	M	J. G. O'Sullivan.
Dublin	I.	M	M. J. Buckley.
Dublin	I.	M	H. V. White.
Dudley	W.M.	M	J. Gammage.
Dukinfield	N.W.	M	S. Hague.
Dumbarton (County)	Scot.	M	J. Andrew.
Dumbartonshire (County)	Scot.	M	A. Wilson.
Dundalk	I.	M	M. Sellars.
Dundee	Scot.	M	J. Thomson.
Dundee	Scot.	M	J. B. Paterson.
Dunedin, New Zealand	A.	M	W. D. R. McCurdie.
Dunfermline (County)	Scot.	M	D. MacKenzie.
Dunfermline (Town Planning)	Scot.	M	J. E. Wilkes.
Dunfermline	Scot.	AM	J. Pryde.
Dunstable	E.	M	J. Stewart.
Durham (Rural)	N.E.	M	G. Gregson.

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TOWN.	DISTRICT.		NAME.
Ealing	E.	M ..	C. Jones.
Ealing	E.	M ..	W. R. Hicks.
Ealing	E.	M ..	W. C. Sillitoe.
Ealing	E.	AM ..	H. Darby.
Ealing	E.	AM ..	S. N. Glass.
East Barnet Valley	E.	M ..	H. York.
East Ham	E.	M ..	J. Birch.
East Ham	E.	M ..	A. T. Bridgewater.
East London, Cape Colony ..	Af.	M ..	J. Powell.
East Malling (Rural)	S.E.	M ..	J. Marshall.
East Molesey	S.E.	M ..	J. Stevenson.
East Preston	S.	AM ..	C. W. Leney.
East Retford	E.M.	M ..	J. D. Kennedy.
East Retford (Rural)	E.M.	M ..	T. Henry.
East Stow (Rural)	E.	M ..	G. F. P. Harrison
Eastbourne	S.E.	M ..	A. E. Prescott.
Eastbourne	S.E.	M ..	J. R. Thackeray.
Eastbourne	S.E.	AM ..	E. N. Keay.
Eastbourne	S.E.	AM ..	D. Ross.
Eastwood	E.M.	M ..	A. G. Wheeler.
Ebbw Vale	W.S.	M ..	T. J. Thomas.
Eccles	N.W.	M ..	T. S. Picton.
Eccles	N.W.	AM ..	A. J. Price.
Edinburgh	Scot.	M ..	A. H. Campbell.
Edinburgh (Highway)..	Scot.	M ..	A. K. Christie.
Edinburgh	Scot.	M ..	A. S. Robertson.
Edinburgh	Scot.	M ..	W. H. Wainwright.
Edinburgh (Water of Leith) ..	Scot.	M ..	L. B. Barclay.
Edinburgh	Scot.	M ..	J. Walker Smith.
Edinburgh	Scot.	M ..	W. Bruce.
Edinburgh	Scot.	M ..	W. Forbes.
Edinburgh	Scot.	AM ..	J. Harkness.
Edinburgh	Scot.	AM ..	J. G. Mitchell.
Edinburgh	Scot.	AM ..	A. W. Morrison.
Edinburgh	Scot.	AM ..	G. W. Tulley.
Edmonton	E.	M ..	C. Brown.
Edmonton	E.	M ..	A. B. Lismer.
Elgin	Scot.	M ..	A. A. Turriff.
Eltham Green	Met.	M ..	R. Findlay.
Enfield	E.	M ..	R. Collins.
Enfield	E.	M ..	J. T. Briscoe.
Enniskillen (County)..	I.	M ..	J. P. Burkitt.
Epsom	S.E.	M ..	E. R. Capon.
Epsom	S.E.	M ..	H. B. Longley.
Erdington	W.M.	M ..	H. H. Humphries.
Eston	N.E.	M ..	C. McDermid.
Eton (Rural)..	E.	M ..	R. Hallam.
Eton (Rural)	E.	M ..	A. Gladwell.
Evesham	W.M.	M ..	H. S. Harvey.
Exeter	S.W.	M ..	T. Moulding.
Exmouth	S.W.	M ..	S. Hutton.
Exmouth	S.W.	M ..	J. C. Matthew.

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TOWN.	DISTRICT.		NAME.
Falkirk	Scot.	M	D. Ronald.
Falkirk	Scot.	M	C. Massie.
Falmouth	S.W.	M	J. S. Walton.
Farnham	S.	M	W. Butler.
Farnborough	S.	M	J. E. Hargreaves.
Farnham	S.E.	M	R. W. Cass.
Faversham	S.E.	M	S. P. Andrews.
Featherstone	N.E.	M	S. Chesney.
Felixstowe	E.	M	H. Clegg.
Fenny Stratford	E.	M	J. Chadwick.
Fife (County) (Highways)	Scot.	M	A. Forbes.
Finchampstead	S.	M	Lt.-Col. A. S. Jones.
Finchley	E.	M	C. J. Jenkin.
Finchley	E.	M	J. H. Catchpole.
Finchley	E.	AM	E. M. Bull.
Finchley	E.	AM	W. S. Gibson.
Finchley	E.	AM	T. G. Newcomen.
Finsbury	Met.	M	P. G. Killick.
Fleet	S.	M	H. J. Chivers.
Flintshire (County)	W.N.	M	S. Evans.
Folkestone	S.E.	M	A. E. Nichols.
Folkestone	S.E.	M	H. O. Jones.
Fremantle, W. Australia	A.	M	H. T. Haynes.
Friern Barnet	E.	M	E. J. Reynolds.
Friern Barnet	E.	M	J. S. King.
Frimley	S.E.	M	T. C. Jones.
Frinton-on-Sea	E.	M	E. M. Bate.
Frome	S.W.	M	F. W. Jones.
Fulwood	N.W.	M	A. E. Coupe.
Gainsborough	E.M.	M	S. W. Parker.
Gainsborough (Water)	E.M.	M	C. F. Brown.
Gateshead	N.E.	M	N. P. Pattinson.
Gellygaer (Rural)	W.S.	M	J. P. Jones.
Gillingham	S.E.	M	J. L. Redfern.
Glamorganshire (County)	W.S.	M	G. A. Phillips.
Glamorganshire (County)	W.S.	M	E. C. Pole.
Glasgow	Scot.	M	T. Nisbet.
Glasgow	Scot.	M	W. C. Easton.
Glasgow (Water)	Scot.	M	J. R. Sutherland.
Glasgow (Water)	Scot.	AM	J. Cochrane.
Glasgow	Scot.	AM	R. T. Henderson.
Glasgow	Scot.	AM	D. McInnes.
Glastonbury	S.W.	M	G. Alves.
Gloucester (County)	S.	M	E. S. Sinnott.
Gloucester	S.	M	R. Read.
Gloucester	S.	M	E. W. A. Carter.
Gloucester	S.	M	R. Phillips.
Glyncorrwg	W.S.	M	W. P. Jones.
Godalming	S.E.	M	J. H. Norris.
Gold Coast	Af.	M	D. S. Palk.

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TOWN.	DISTRICT.		NAME.
Goole	N.E.	M	C. G. Bradley.
Goole	N.E.	AM	J. Gardner.
Gorton	N.W.	M	C. J. Lomax.
Gosforth	N.E.	M	G. Nelson.
Gosport	S.	M	W. H. Fry.
Gosport and Alverstoke	S.	M	H. Frost.
Gosport and Alverstoke	S.	M	F. C. Harvey.
Govan	Scot.	M	F. G. Holmes.
Grangemouth	Scot.	M	D. A. Donald.
Grantham	E.M.	M	W. Wright.
Gravesend	S.E.	M	F. T. Grant.
Gravesend	S.E.	M	R. Saunders.
Grays Thurrock	E.	M	A. C. James.
Great Yarmouth	E.	M	J. W. Cockrill.
Great Yarmouth	E.	AM	L. Leeper.
Great Yarmouth	E.	AM	O H. Cockrill.
Greenock	Scot.	M	W. D. Low.
Greenwich	Met.	M	C. P. Smith.
Grey County, New Zealand	A.	M	J. Higgins.
Grimsby	E.M.	M	H. G. Whyatt.
Grimsby	E.M.	M	J. G. R. Baxter.
Grimsby	E.M.	AM	H. Heap.
Guernsey	S.	M	T. J. Guilbert.
Guildford	S.E.	M	C. G. Mason.
Guildford	S.E.	M	R. Snodgrass.
Guildford (Rural)	S.E.	M	J Anstee.
Guildford	S.E.	AM	P. I. Payne.
Guildford, West Australia	A.	M	G. S. L. Bains.
Hackney	Met.	M	N. Scorgie.
Hadham and Stansted (Rural)	E.	M	E. T. Watts.
Halifax (Rural)	N.E.	M	F. Gordon.
Hamilton	Scot.	M	W. H. Purdie.
Hamilton, New Zealand	A.	M	S. B. Sims.
Hammersmith	Met.	M	H. Mair.
Hammersmith	Met.	AM	E. W. Ludford.
Hampshire (County)	S.	M	W. J. Taylor.
Hampshire (County)	S.	AM	G. O. Lockwood.
Hampstead	Met.	M	O. E. Winter.
Hampstead	Met.	M	J. Williams.
Hampton	E.	M	S. H. Chambers.
Hampton Wick	E.	M	P. Taylor.
Hanwell	E.	M	S. W. J. Barnes.
Harlesden	E.	AM	R. Fisher.
Harrogate (Water)	N.E.	AM	A. S. West.
Harrow	E.	M	J. P. Bennetts.
Harrow	E.	M	T. Charles.
Haslingden	N.W.	M	J. S. Green.
Haslingden	N.W.	AM	R. Taylor.
Hastings	S.E.	M	P. H. Palmer.
Hastings	S.E.	M	G. F. Miller.

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TOWN.	DISTRICT.		NAME.
Hatch End	E.	M	C. A. Woodbridge.
Hawick, N.B.	Scot.	M	Chas. Brown.
Hay	W.M.	AM	A. E. Smith.
Herden Bridge	N.E.	M	T. Waddingham.
Heckmondwike	N.E.	M	J. Saville.
Hemel Hempstead	E.	M	W. R. Locke.
Hemel Hempstead (Rural)	E.	M	T. H. Lighbody.
Hendon (Rural)	E.	M	J. A. Webb.
Hendon (Rural)	E.	M	W. Hosken.
Hereford (County)	W.M.	M	G. H. Jack.
Herford	W.M.	M	J. Parker.
Hereford (Rural)	W.M.	M	R. S. Lloyd.
Herne Bay	S.E.	M	F. W. J. Palmer.
Hertford	E.	M	J. H. Jevons.
Hertford	E.	AM	H. J. Chapman.
Hertfordshire	E.	M	T. Bowes.
Hertfordshire (Highways)	E.	M	E. Parry.
Heston and Isleworth	E.	M	J. G. Carey.
Heysham	N.W.	M	H. Miller.
Heywood	N.W.	M	J. B. Nuttall.
Heywood	N.W.	AM	E. G. Hutson.
Heywood (Water)	N.W.	M	J. Diggle.
Heywood (Water)	N.W.	M	J. S. Diggle.
High Wycombe	E.	M	T. J. Rushbrooke.
High Wycombe	E.	M	A. L. Grant.
Hinckley	E.M.	M	E. H. Crump.
Hitchin	E.	M	A. T. Blood.
Hobson, New Zealand (County)	A.	M	H. Hammond.
Holborn	Met.	M	E. F. Spurrell.
Holborn	Met.	M	O. Cattlin.
Holborn	Met.	M	A. Greenwell.
Holsworthy (Rural)	S.W.	M	F. J. Harris.
Holyhead	W.N.	M	A. Asquith.
Hong Kong	A.	M	H. E. Goldsmith.
Hong Kong	A.	M	A. F. Churchill.
Hong Kong	A.	M	H. E. Goldsmith.
Hong Kong	A.	AM	J. T. Longstaff.
Hong Kong	A.	AM	T. L. Perkins.
Hornsea	N.E.	M	W. E. Warburton.
Horbury	N.E.	M	W. Sugars.
Hornsey	E.	M	E. J. Lovegrove.
Hornsey	E.	M	A. C. Collis-Adamson.
Hornsey	E.	AM	W. S. Richmond.
Hounslow	E.	M	S. F. R. Carter.
Hove	S.E.	M	H. H. Scott.
Hove	S.E.	M	G. Livingstone.
Hove	S.E.	AM	M. B. Bennett.
Howrah, Bengal	Ind.	M	A. Hale.
Hoylake	N.W.	M	W. H. Maitland.
Hoylake	N.W.	M	R. W. Fraser.
Hoylake	N.W.	AM	H. T. Taylor.
Hoyland Nether	N.E.	M	F. J. Thackray.

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TOWN.	DISTRICT.		NAME.
Huddersfield	N.E.	M	K. F. Campbell.
Huddersfield (Gas)	N.E.	M	E. A. Harman.
Huddersfield	N.E.	M	H. Sutcliffe.
Huddersfield	N.E.	AM	R. B. Donald.
Huelva, Spain	A.	M	W. T. Curry.
Hull	N.E.	M	A. E. White.
Hull	N.E.	M	P. Gaskell.
Hull	N.E.	AM	W. H. Goldsmith.
Hungerford (Rural) (Highways)	S.	M	W. S. Raine.
Huntingdon (County)	E.	M	H. J. G. Leete.
Hyde	N.W.	AM	N. N. Bose.
Hythe	S.E.	M	Chris. Jones.
Ilford	E.	M	H. Shaw.
Ilford	E.	M	G. G. Shepherd.
Ilfracombe	S.W.	M	O. M. Prouse.
Ilkeston	E.M.	AM	F. W. Wright.
Inverness	Scot.	M	T. H. Scott.
Inverness (County) (Highways)	Scot.	M	R. Robertson.
Ipswich	E.	M	E. Buckham.
Irlam	N.W.	M	R. H. Winterbottom.
Isle of Ely, North (County)	E.	M	H. F. Simpson.
Isle of Ely, South (County)	E.	M	R. S. W. Perkins.
Isle of Thanet (Rural)	S.E.	M	G. L. Butterworth.
Isle of Wight (Rural)	S.	M	H. B. Cullin.
Isle of Wight (Rural) (Highways)	S.	M	L. A. Cozens.
Islington	Met.	M	J. P. Barber.
Islington	Met.	M	J. E. Cooke.
Islington	Met.	AM	P. A. Moss.
Islington	Met.	AM	A. Vernon.
Jarrow	N.E.	M	J. S. Weir.
Johannesburg	Af.	M	C. Aburrow.
Johannesburg	Af.	M	W. Ingham.
Karachi	Ind.	M	M. Lea.
Kedah, Malay States	A.	M	J. Gorman.
Keighley	N.E.	M	W. Fowlds.
Keighley	N.E.	AM	H. Sanderson.
Kendal	N.W.	M	F. W. Oxberry.
Kenilworth	W.M.	M	S. Douglas.
Kensington	Met.	M	A. R. Finch.
Kent (County)	S.E.	M	H. P. Maybury.
Kent (County)	S.E.	M	F. R. Ruck.
Keswick	N.W.	M	W. Hodgson.
Kettering	E.	M	T. R. Smith.
Keynsham (Rural)	S.W.	M	H. M. Bennett.
Keynsham (Rural)	S.W.	M	H. A. Endsor.
Khartoum City	Af.	M	W. H. McLean.
Kidderminster (Rural)	W.M.	M	G. J. Shepherd.

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TOWN.	DISTRICT.		NAME.
Kilkenny (County)	I.	M	A. M. Burden.
Kilmarnock	Scot.	M	R. Blackwood.
Kingston, Jamaica	A.	M	P. R. A. Willoughby.
Kingston, Jamaica	A.	M	C. V. Abrahams.
Kingston-by-Sea	S.E.	M	A. J. Catt.
Kingston-on-Thames	S.E.	M	R. H. Clucas.
Kirkcaldy	Scot.	M	J. L. Lumsden.
Kirkcudbright	Scot.	M	J. D. Smith.
Kirklam	N.W.	M	T. H. Maxwell.
Kirriemuir, N.B.	Scot.	M	J. S. Bruce.
Kiveton Park (Rural)	N.E.	M	F. Hewitt.
Klipfontein	Af.	M	A. C. V. Baines.
Knaresborough	N.E.	M	R. E. Wilson.
Kroonstad, Orange River Colony	Af.	M	F. Brown.
Krugersdorp, Transvaal	Af.	M	R. A. Webster.
Lambeth	Met.	M	H. C. J. Edwards.
Lambeth	Met.	M	H. E. Anderson.
Lanark (County)	Scot.	M	W. L. Douglass.
Lanark (County)	Scot.	M	W. A. Chapman.
Lanark (County)	Scot.	M	D. MacBean.
Lanark (County)	Scot.	M	R. Spittal.
Lanark (County)	Scot.	M	J. Watson.
Lanark (County)	Scot.	AM	G. E. Marr.
Lanark (County)	Scot.	AM	T. M. Stephen.
Lancashire (County)	N.W.	M	W. H. Schofield.
Lancaster (Water)	N.W.	M	A. G. Bradshaw.
Langport	S.W.	M	J. Mathison.
Lathom and Burscough	N.W.	M	T. Burrows.
Leatherhead	S.E.	M	S. B. Drake.
Ledbury	W.M.	M	R. G. Gurney.
Leeds	N.E.	M	W. T. Lancashire.
Leeds (Sewerage)	N.E.	M	G. A. Hart.
Leeds	N.E.	M	R. B. Holt.
Leeds	N.E.	M	W. Dixon.
Leeds	N.E.	AM	H. P. Foster.
Leek	W.M.	M	W. E. Beacham.
Leek	W.M.	M	A. M. Kinnison.
Leicester (County)	E.M.	M	S. P. Pick.
Leicester	E.M.	M	E. G. Mawbey.
Leicester	E.M.	M	W. H. A. Court.
Leicester	E.M.	AM	P. H. A. Smith.
Leicestershire	E.M.	M	C. T. Garratt.
Leigh	N.W.	M	T. Hunter.
Leigh	N.W.	M	T. A. Clare.
Leigh-on-Sea	E.	M	J. W. Liversedge.
Leith, N.B.	Scot.	M	J. R. Findlay.
Leitrim (County)	I.	M	E. O'N. Clarke.
Lewes	S.E.	M	H. Card.
Lewisham	Met.	M	E. Van Putten.
Lewisham	Met.	AM	W. R. Davidge.
Leyland	N.W.	M	M. H. Wilkinson.

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TOWN.	DISTRICT.		NAME.
Leyton	E.	M	E. H. Essex.
Leyton	E.	AM	W. Jennings.
Leyton	E.	AM	J. W. Trodd.
Leytonstone	E.	M	L. W. Hogbin.
Lichfield	W.M.	M	W. B. Chancellor.
Lichfield	W.M.	AM	F. Stanyer.
Lichfield (Rural)	W.M.	AM	C. O. Rawstron.
Limerick (County)	I.	M	J. Horan.
Lincoln (Holland) (County)	E.M.	M	T. J. Peacock.
Lincoln (Kesteven) (County)	E.M.	M	W. B. Purser.
Lincoln (Lindsey) (County)	E.M.	M	J. Thropp.
Lincoln	E.M.	M	R. A. MacBrair.
Litherland	N.W.	M	A. H. Carter.
Littleborough	N.W.	M	G. H. Wild.
Littlehampton	S.E.	M	H. Howard.
Liverpool	N.W.	M	J. A. Brodie.
Liverpool	N.W.	AM	F. J. K. Conway.
Liverpool	N.W.	AM	A. W. Panton.
Liversedge	N.E.	M	A. Rothera.
Llandudno	W.N.	M	E. P. Stephenson.
Llantrissant (Rural)	W.S.	M	G. S. Morgan.
London (County)	Met.	M	Sir M. Fitzmaurice.
London (County)	Met.	M	J. E. Worth.
London (County)	Met.	AM	H. W. Line.
London (County)	Met.	M	J. P. Harris.
London (County)	Met.	M	R. M. Gloyne.
London (County)	Met.	AM	W. H. Pickin.
London (County)	Met.	AM	F. Reed.
London (Water)	Met.	M	W. B. Bryan.
London	Met.	M	F. Sumner.
London	Met.	M	E. E. Finch.
London	Met.	M	G. D. Trusler.
London	Met.	M	T. H. Dunch.
London	Met.	M	C. Mayne.
London (Port of)	Met.	M	A. P. Lambert.
London (Port of)	Met.	M	E. E. L. Vincent.
London (Port of)	Met.	M	C. R. S. Kirkpatrick.
Londonderry (County)	I.	M	C. L. Boddie.
Londonderry	I.	M	M. A. Robinson.
Long Eaton	E.M.	M	W. A. Harrison.
Longton	W.M.	M	J. W. Wardle.
Loughborough	E.M.	M	A. H. Walker.
Lower Bebington	N.W.	M	H. W. Corrie.
Lowestoft	E.	M	G. H. Hamby.
Lucknow (United Provinces)	Ind.	M	H. Lane Brown.
Ludlow	W.M.	M	J. A. Spreckley.
Lurgan	I.	M	H. Shillington.
Luton	E.	M	J. W. Tomlinson.
Luton	E.	M	J. Ashurst.
Lytham	N.W.	M	A. J. Price.
Lyme Regis	S.W.	M	F. H. McDonnell.

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TOWN.	DISTRICT.		NAME.
MACCLESFIELD	N.W.	M	S. C. Baggott.
MACCLESFIELD (Rural)	N.W.	M	J. Thorpe.
MADRAS	A.	M	E. P. Richards.
MAESTEG	W.S.	M	S. J. Harpur.
MAESTEG	W.S.	AM	W. H. Hughes.
MAIDSTONE	S.E.	M	T. F. Bunting.
MAIDSTONE (Rural)	S.E.	M	T. A. Busbridge.
MALDEN	S.E.	M	R. H. Jeffes.
MALDON	E.	M	T. R. Swales.
MALVERN	W.M.	M	W. O. Thorp.
MANCHESTER	N.W.	M	T. De C. Meade.
MANCHESTER	N.W.	M	F. R. Gibbins.
MANCHESTER	N.W.	M	G. Fitton.
MANCHESTER	N.W.	M	Alfred M. Fowler.
MANCHESTER	N.W.	M	C. E. Newton.
MANCHESTER	N.W.	M	J. Swarbrick.
MANCHESTER	N.W.	M	J. W. Wiles.
MANCHESTER	N.W.	M	J. P. Wilkinson.
MANCHESTER	N.W.	AM	G. H. Bayley.
MANCHESTER	N.W.	AM	E. W. Booth.
MANCHESTER	N.W.	AM	D. Furness.
MANCHESTER	N.W.	AM	H. Mattinson.
MANCHESTER	N.W.	AM	W. T. Retford.
MANCHESTER	N.W.	AM	W. H. Johnson.
MANSFIELD	E.M.	M	T. P. Collinge.
MANSFIELD	E.M.	AM	J. A. Tonge.
MANSFIELD WOODHOUSE	E.M.	M	F. P. Cook.
MARGATE	S.E.	M	E. A. Borg.
MARGATE	S.E.	M	J. S. Sawdon.
MARKET HARBOROUGH	E.M.	M	H. G. Coales.
MARLOW	E.	M	T. N. W. Watts.
MARPLE	N.W.	M	D. J. Diver.
MARYLEBONE	Met.	M	J. A. P. Waddington.
MARYLEBONE	Met.	M	J. Gair.
MATARA, CEYLON	Ind.	AM	H. K. De Kretser.
MATLOCK	E.M.	M	W. Jaffrey.
MAXWELLTOWN	Scot.	M	J. McL. Bowie.
MELFORD (Rural)	E.	M	W. Carver.
MELTON MOWBRAY	E.M.	M	E. Jeeves.
MERTHYR TYDVIL	W.S.	M	T. F. Harvey.
MERTHYR TYDVIL	W.S.	AM	D. L. Jones.
MERTON	S.E.	M	G. Jerram.
MEXBOROUGH	N.E.	M	G. F. Carter.
MIDDELBURG, TRANSVAAL	Af.	M	W. F. Curry.
MIDDLESBROUGH	N.E.	M	S. E. Burgess.
MIDDLESEX (County)	E.	M	H. T. Wakelam.
MIDDLESEX (County)	E.	M	W. E. F. Crooke.
MIDDLESEX (County)	E.	AM	W. Ashbee.
MIDDLETON	N.W.	M	W. Welburn.
MIDHURST (Rural)	S.E.	M	A. G. Gibbs.
MIDSOMER NORTON	S.W.	M	C. H. Sunderland
MIDSOMER NORTON	S.W.	M	W. F. Bird.

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TOWN.	DISTRICT.		NAME.
Milnrow	N.W.	M	R. B. Jones.
Minehead	S.W.	M	J. H. Woolston Smith
Monmouth	W.S.	M	G. F. Grimwood.
Monmouthshire (County)	W.S.	M	W. Tanner.
Morecambe	N.W.	M	J. W. Hipwood.
Morley	N.E.	M	W. E. Putman.
Morley	N.E.	M	F. Turner.
Mossley	N.W.	M	R. H. Buckley.
Musselburgh, N.B.	Scot.	M	G. Landale.
Mynyddislwyn	W.S.	M	E. W. Edwards.
Nairobi, British East Africa	Af.	M	J. F. Davidson.
Nantyglo and Blaina	W.S.	M	W. J. Davies.
Neath	W.S.	M	D. M. Jenkins.
Neath (Rural)	W.S.	M	W. E. C. Thomas.
Neath	W.S.	AM	A. H. V. Taylor.
Nelson	N.W.	M	W. Shackleton.
Nelson	N.W.	M	C. T. Copley.
Nelson (Water)	N.W.	M	S. Whitehead.
Nelson	N.W.	AM	A. V. Cole.
Nelson	N.W.	AM	W. Moser.
Neston	N.W.	M	C. E. Senior.
New Barnet	E.	M	C. Vawser.
New Brighton	N.W.	AM	F. D. Ward.
New Brunswick	A.	AM	G. F. Palmer.
New Malden	S.E.	M	G. W. Seels.
New Mills	E.M.	M	W. C. Sheard.
Newark	E.M.	M	G. Sheppard.
Newark	E.M.	M	J. Saunders.
Newark	E.M.	M	T. P. Frank.
Newark (Rural)	E.M.	M	R. Oakden.
Newburn-on-Tyne	N.E.	M	T. Gregory.
Newbury	S.	M	S. J. L. Vincent.
Newbury	S.	AM	O. S. Webb.
Newcastle-on-Tyne	N.E.	M	W. J. Steele.
Newcastle-on-Tyne	N.E.	M	J. E. Parker.
Newcastle-on-Tyne	N.E.	M	H. W. Taylor.
Newmarket	E.	M	W. H. Eley.
Newport, Mon.	W.S.	M	H. Tremelling.
Newport, Mon.	W.S.	AM	I. F. Shellard.
Newquay	S.W.	AM	A. D. Braggins.
Newry	I.	M	C. Blaney.
Newton Abbot	S.W.	M	C. D. White.
Newton-in-Makerfield (Water)	N.W.	M	R. T. Surtees.
Newtownards	I.	AM	J. L. Peacock.
North Shields	N.E.	M	J. P. Spencer.
Northampton	E.	M	A. Fidler.
Northampton	E.	AM	H. B. E. Brown.
Northampton	E.	AM	A. E. Loach.
Northampton	E.	AM	W. H, Letheren.
Northumberland (County)	N.E.	M	J. A. Bean.

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TOWN.	DISTRICT.		NAME.
Northwich	N.W.	M	J. Brooke.
Norwich	E.	M	A. E. Collins.
Norwich	E.	M	H. Collins.
Norwich	E.	M	W. G. Powell.
Norwich (Sewerage)	E.	AM	H. Wood.
Nottingham (County)	E.M.	M	E. P. Hooley.
Nottingham	E.M.	M	A. Brown.
Nottingham	E.M.	M	T. W. Gordon.
Nottingham	E.M.	AM	A. H. Elliott.
Nottingham	E.M.	AM	W. N. Thomas.
Nuneaton	W.M.	M	F. C. Cook.
Nuneaton	W.M.	AM	E. J. Goodacre.
Nuneaton	W.M.	M	R. C. Moon.
Oakworth	N.E.	M	J. Spencer.
Oldbury	W.M.	M	T. H. Shipton.
Oldham	N.W.	M	J. H. Bentley.
Oldham	N.W.	AM	R. B. Holden.
Ossett	N.E.	M	H. Holmes.
Oswestry	W.M.	M	G. W. Lacey.
Otley	N.E.	M	C. F. Hodgson.
Ottawa	A.	AM	W. H. Carson.
Ottawa, Canada	A.	AM	L. McL. Hunter.
Oundle	E.	AM	B. L. Siddons.
Oxford	S.	M	W. H. White.
Oxford	S.	M	J. F. Richardson.
Oxfordshire (County)	S.	M	S. Stallard.
Paddington	Met.	M	E. B. B. Newton.
Padiham	N.W.	M	J. Gregson.
Paignton	S.W.	M	C. O. Baines.
Paignton	S.W.	M	F. W. E. Vanstone.
Paignton	S.W.	AM	C. D. H. Vanstone.
Paisley	Scot.	M	J. Lee.
Paisley	Scot.	AM	M. Reid.
Partick	Scot.	M	J. Bryce.
Peebles (County)	Scot.	M	R. S. Anderson.
Pemberton	N.W.	M	G. Heaton.
Pembroke Dock	W.S.	M	H. R. Crabb.
Penang	A.	M	L. M. Bell.
Penang	A.	M	C. G. May.
Penang	A.	AM	O. H. Wait.
Penarth	W.S.	M	E. I. Evans.
Penge	S.E.	M	H. W. Longdin.
Penrith	N.W.	M	J. J. Knewstubb.
Perth	Scot.	M	R. McKillop.
Perthshire, West (County)	Scot.	M	W. L. Gibson.
Peterborough	E.	M	J. W. Walshaw.
Petersfield	S.	M	H. V. Snook.
Pinner	E.	M	G. Weston.

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TOWN.	DISTRICT.		NAME.
Plymouth	S.W.	M	J. Paton.
Plymouth	S.W.	AM	J. Wibberley.
Plumstead Common	Met.	AM	W. T. Schlund.
Pokesdown	S.	M	E. W. Ingamells.
Pollokshaws	Scot.	M	D. Burns.
Pontardawe (Rural)	W.S.	M	J. Morgan.
Pontefract	N.E.	M	J. E. Pickard.
Pontypridd	W.S.	AM	G. L. Morgan.
Poole	S.W.	M	S. J. Newman.
Poplar	Met.	M	H. Heckford.
Poplar	Met.	AM	W. P. Wrack.
Port Elizabeth, South Africa	Af.	M	A. S. Butterworth.
Port Glasgow	Scot.	M	J. Murray.
Portadown	I.	M	W. Wilson.
Porthcawl	W.S.	M	A. S. Lilley.
Portishead	S.W.	M	F. H. Smith.
Portland	S.W.	M	R. S. Henshaw.
Portslade-by-Sea	S.E.	M	A. T. Allen.
Portsmouth	S.	M	G. Cowan.
Portsmouth	S.	M	R. J. Jenkins.
Prahran, Victoria	A.	M	W. Calder.
Prahran, Victoria	A.	AM	A. W. D. Brown.
Prestatyn	W.N.	M	F. Wilkinson.
Preston	N.W.	M	J. S. Bullough.
Preston	N.W.	M	H. Nuttall.
Prestwich	N.W.	M	S. H. Morgan.
Pretoria (P.W.D.)	Af.	M	R. Robertson.
Pretoria (Drainage)	Af.	M	H. C. Kirby.
Pretoria (Water)	Af.	M	J. Riley.
Putney	Met.	M	J. C. Radford.
Putney	Met.	M	W. Weaver.
Ramsbottom	N.W.	M	T. H. Bell.
Ramsbury (Rural)	S.	M	W. Strickland.
Ramsgate	S.E.	M	T. G. Taylor.
Rangoon	A.	M	L. P. Marshall.
Rangoon	A.	M	W. Bennett.
Rangoon, West	A.	M	W. G. Longdin.
Rawtenstall	N.W.	M	J. Johnson.
Rawtenstall	N.W.	M	P. Holt.
Reading	S.	M	R. H. H. Watson.
Redcar	N.E.	M	J. Howcroft.
Redditch	W.M.	M	A. J. Dickinson.
Redruth	S.W.	M	W. J. Merrett.
Regina, Canada	A.	M	R.O.Wynne Roberts.
Reigate	S.E.	M	F. T. Clayton.
Renfrewshire (County)	Scot.	M	J. Murray.
Rhondda	W.S.	M	W. J. Jones.
Rhondda	W.S.	M	F. Read.
Richmond	S.E.	M	J. H. Brierley.
Richmond	S.E.	M	W. Fairley.

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TOWN.	DISTRICT.		NAME.
Richmond	S.E.	AM	H. B. Crossley.
Rickmansworth	E.	M	A. Freeman.
Rio de Janiero	A.	AM	T. C. Richardson.
Ripon	N.E.	AM	A. Barlow.
Rochdale	N.W.	M	S. S. Platt.
Rochdale	N.W.	M	H. Yarwood.
Rochdale	N.W.	M	R. R. Jones.
Rochester	S.E.	M	W. Banks.
Rochester	S.E.	AM	C. G. Kent.
Rochford (Rural)	E.	M	H. T. Sidwell.
Roscommon (County)	I.	M	C. J. Mulvany.
Rotherham	N.E.	M	E. B. Martin.
Rotherham (Rural)	N.E.	M	F. C. Jenkinson.
Rothwell	N.E.	M	J. Southwart.
Rowley Regis	W.M.	M	W. H. Brettell.
Rugeley	W.M.	M	W. E. Rogers.
Ruislip-Northwood	E.	M	W. L. Carr.
Runcorn	N.W.	M	J. Wilding.
Rushden	E.	M	W. B. Madin.
Rutland (County)	E.M.	M	J. Richardson.
Ryton-on-Tyne	N.E.	M	J. P. Dalton.
Saffron Walden	E.	M	A. H. Forbes.
Saffron Walden	E.	AM	C. D. Bright.
St. Albans	E.	M	G. Ford.
St. Andrews	Scot.	M	W. Watson.
St. Austell (Water)	S.W.	M	E. D. Groves.
St. Catharines, Ontario	A.	M	R. D. Brown.
St. Helens, Lancs.	N.W.	M	A. W. Bradley.
St. Helens	N.W.	M	J. R. Mead.
St. Ives (Water)	S.W.	M	S. Palmer.
St. Ives and Ramsay	E.	AM	J. E. Cardell.
St. Pancras	Met.	M	W. N. Blair.
St. Pancras	Met.	M	E. W. Swinstead.
Sale	N.W.	M	W. Holt.
Salford	N.W.	M	T. W. B. Gent.
Salford	N.W.	AM	J. Openshaw.
Salford	N.W.	AM	A. P. Statham.
Salisbury	S.	M	W. J. Goodwin.
Saltburn-by-the-Sea	N.E.	M	J. Draper.
San Pedro	Af.	M	I. T. Hawkins.
Sandown, I. of W.	S.	M	L. G. Dasher.
Scarborough	N.E.	M	H. W. Smith.
Scarborough	N.E.	M	H. Richardson.
Scarborough (Rural)	N.E.	M	J. A. Iveson.
Scunthorpe	E.M.	M	C. C. Gray.
Seccondee, Gold Coast	Af.	M	A. G. Whitfeild.
Sedgfield, Co. Durham (Rural)	N.E.	M	J. Stones.
Selkirk	Scot.	M	J. Pritty.
Sevenoaks	S.E.	M	S. Towlson.
Shanghai	A.	M	C. H. Godfrey.

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TOWN.	DISTRICT.		NAME.
Shanghai	A.	M	J. E. Needham.
Shanghai	A.	AM	H. E. Pollard.
Shanklin	S.	M	E. C. Cooper.
Sheffield	N.E.	M	C. F. Wike.
Sheffield (Highways)	N.E.	M	W. J. Hadfield.
Sheffield	N.E.	AM	W. C. Fenton.
Sheffield	N.E.	AM	J. Hassall.
Sheffield	N.E.	AM	A. C. Hodge.
Sheffield	N.E.	AM	S. H. Newsome.
Sheffield	N.E.	AM	F. Simms.
Sheffield (Highways)	N.E.	AM	E. W. Turner.
Sheffield	N.E.	AM	H. E. Ollevant.
Sheppey (Rural)	S.E.	AM	F. W. S. Stanton.
Sheringham	E.	M	F. Hall Smith.
Shrewsbury	W.M.	M	W. C. Eddowes.
Shropshire (County)	W.M.	M	A. T. Davis.
Sierra Leone	A.	M	A. S. Bradshaw.
Sierra Leone	A.	AM	W. S. Lake.
Singapore	A.	M	R. Peirce.
Singapore	A.	M	B. Ball.
Singapore (Water)	A.	M	F. E. Marsh.
Singapore	A.	M	H. V. Towner.
Singapore (Water)	A.	M	S. G. Williams.
Skelton-in-Cleveland	N.E.	M	W. P. Robinson.
Skipton	N.E.	M	A. E. W. Aldridge.
Skipton (Rural)	N.E.	M	A. Rodwell.
Sleaford	E.M.	M	S. F. Clare.
Sleaford	E.M.	M	J. Clare.
Slough	E.	M	W. W. Cooper.
Slough	E.	M	J. Baker.
Smallthorne	W.M.	M	J. W. Deane.
Smethwick	W.M.	M	A. Hosken.
Solihull (Rural)	W.M.	M	A. E. Currall.
Somerset (County)	S.W.	M	H. T. Chapman.
South Kensington	Met.	AM	S. G. Turner.
South Shields	N.E.	M	L. Roseveare.
South Shields	N.E.	M	A. J. Denton.
South Shields (Rural)	N.E.	M	T. T. Bains.
South Stoneham (Rural)	S.	M	F. Heather.
Southall Norwood	E.	M	R. Brown.
Southall Norwood	E.	AM	J. B. Thomson.
Southampton	S.	M	J. A. Crowther.
Southampton	S.	M	Sir J. Lemon.
Southampton	S.	M	H. J. Weston.
Southampton	S.	AM	J. H. Blizard.
Southampton	S.	AM	E. F. Harmer.
Southampton	S.	AM	E. E. Mann.
Southampton	S.	AM	W. H. Masters.
Southampton	S.	AM	P. Millar.
Southampton	S.	AM	R. Nicholls.
Southend-on-Sea	E.	M	E. J. Elford.
Southend-on-Sea	E.	M	R. H. Dyer.

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TOWN.	DISTRICT.		NAME.
Southend-on-Sea	E. ..	AM ..	E. J. Messent.
Southend-on-Sea	E. ..	M ..	H. C. Whitehead.
Southgate	E. ..	M ..	C. G. Lawson.
Southgate	E. ..	M ..	D. S. Sutherland.
Southgate	E. ..	AM ..	R. Phillips.
Southport	N.W. ..	M ..	R. P. Hirst.
Southport	N.W. ..	M ..	B. A. Nelson.
Southport	N.W. ..	AM ..	H. Goodfellow.
Southwark	Met. ..	M ..	A. Harrison.
Southwick	S.E. ..	M ..	G. W. Warr.
Southwick-on-Wear	N.E. ..	M ..	W. B. Thomas.
Sowerby Bridge	N.E. ..	M ..	G. E. Wrigley.
Stafford (County) (Highways) ..	W.M. ..	M ..	J. Moncur.
Stafford	W.M. ..	M ..	W. Plant.
Stafford	W.M. ..	M ..	W. Blackshaw.
Staines	E. ..	M ..	E. J. Barrett.
Staines (Rural)	E. ..	M ..	G. W. Manning.
Stalybridge	N.W. ..	M ..	J. N. White.
Stamford	E.M. ..	M ..	F. R. Ryman.
Stepney	Met. ..	M ..	M. W. Jameson.
Stepney	Met. ..	M ..	B. J. Belsher.
Stepney	Met. ..	AM ..	B. W. Stuttle.
Stepney	Met. ..	AM ..	C. A. Hazeltine.
Steyning, West	S.E. ..	M ..	F. Slaughter.
Stirling	Scot. ..	M ..	A. H. Goudie.
Stockport	N.W. ..	M ..	J. Atkinson.
Stockport	N.W. ..	M ..	A. W. Ward.
Stockton-on-Tees	N.E. ..	M ..	M. H. Sykes.
Stockton-on-Tees	N.E. ..	M ..	G. C. Mitchell.
Stoke Newington	Met. ..	M ..	W. F. Loveday.
Stoke Newington	Met. ..	AM ..	A. W. Curry.
Stoke-on-Trent	W.M. ..	M ..	M. A. Piercy.
Stoke-on-Trent	W.M. ..	M ..	A. Burton.
Stoke-on-Trent	W.M. ..	M ..	J. R. Heath.
Stoke-on-Trent	W.M. ..	M ..	J. Lobley.
Stoke-on-Trent	W.M. ..	AM ..	H. Pool.
Stone	W.M. ..	M ..	A. R. Ridout.
Stourbridge	W.M. ..	M ..	F. Woodward.
Stourbridge	W.M. ..	M ..	W. Fiddian.
Stourbridge	W.M. ..	AM ..	A. Grove.
Stowmarket	E. ..	M ..	G. W. Lingwood.
Strand	Met. ..	AM ..	H. W. Cubitt.
Stratford	E. ..	AM ..	R. W. Burgess.
Stratford and Wolverton (Rural)	E. ..	M ..	A. E. Abbott.
Stratford-on-Avon	W.M. ..	M ..	R. Dixon.
Stratford-on-Avon	W.M. ..	M ..	T. T. Allen.
Streatham	Met. ..	M ..	H. J. Marten.
Streatham Hill	Met. ..	AM ..	L. G. Roberts.
Stretford	N.W. ..	M ..	E. Worrall.
Stretford	N.W. ..	AM ..	E. Parker.
Stroud	S. ..	M ..	G. P. Milnes.

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TOWN.	DISTRICT.		NAME.
Sudbury	E.	M	W. I. Tait.
Suffolk, East (County)	E.	M	H. Miller.
Suffolk, West (County)	E.	M	A. A. Hunt.
Sunbury-on-Thames	E.	M	H. F. Coales.
Sunderland	N.E.	AM	G. H. Whitaker.
Sunderland (Rural)	N.E.	M	T. Young.
Surbiton	S.E.	M	H. T. Mather.
Surbiton	S.E.	AM	W. B. Smith.
Surrey (County)	S.E.	M	A. Dryland.
Surrey (County)	S.E.	M	F. Grove.
Sussex, East (County)	S.E.	M	F. J. Wood.
Sussex, West (County)	S.E.	M	H. W. Bowen.
Sussex, West (County)	S.E.	AM	H. Criswell.
Sussex, West (County)	S.E.	AM	S. C. Lloyd.
Sutton, Surrey	S.E.	M	W. H. Grieves.
Sutton, Surrey	S.E.	AM	H. H. Cowlishaw.
Sutton, Surrey	S.E.	AM	J. Owen.
Sutton, Surrey	S.E.	AM	W. Wright.
Sutton Coldfield	W.M.	M	W. A. H. Clarry.
Sutton Coldfield	W.M.	AM	F. W. Cross.
Sutton-in-Ashfield	E.M.	M	W. Burn.
Swadlincote	E.M.	M	T. Kidd.
Swanage	S.W.	M	J. S. Senior.
Swansea	W.S.	M	G. Bell.
Swansea	W.S.	M	G. Swarbrick.
Swansea	W.S.	AM	G. H. Bell.
Swansea (Rural)	W.S.	M	T. T. Williams.
Swindon	S.	M	H. J. Hamp.
Swinton	N.W.	M	H. Entwisle.
Sydney, New South Wales	A.	M	J. M. Small.
Sydney, New South Wales	A.	M	R. W. Richards.
Sydney, New South Wales	A.	AM	B. L. Siddons.
Tadcaster (Rural)	N.E.	M	H. C. Wood.
Tadcaster (Rural) (Highways)	N.E.	M	T. Scott.
Tamworth	W.M.	M	F. E. G. Bradshaw.
Tamworth (Rural)	W.M.	M	H. J. Clarson.
Tanfield	N.E.	M	R. Heslop.
Taunton	S.W.	M	D. Edwards.
Te Kuiti, New Zealand	A.	M	L. G. P. Spencer.
Teddington	E.	M	M. Hainsworth.
Teddington	E.	AM	J. Skillman.
Tenbury (Rural)	W.M.	M	R. W. Jarvis.
Tewkesbury	S.W.	M	W. Bidler.
Thetford	E.	M	W. Jones.
Thornton	N.W.	M	H. Fenton.
Thornton Heath	S.E.	AM	A. H. Quick.
Tilbury	E.	M	S. A. Hill Willis.
Tipton	W.M.	M	W. H. Jukes.
Tiverton	S.W.	M	J. Siddalls.
Tiverton	S.W.	M	H. C. Poole.

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TOWN.	DISTRICT.		NAME.
Tobermory (County) (Highways)	Scot.	M	D. Cattanach.
Todmorden	N.E.	M	J. A. Heap.
Todmorden	N.E.	M	J. H. Williams.
Tokio, Japan	A.	M	B. Kusakabe.
Tokio, Japan	A.	M	R. Hara.
Tokio, Japan	A.	M	S. Yonemoto.
Tonbridge	S.E.	M	W. L. Bradley.
Tonbridge (Rural)	S.E.	M	F. Harris.
Toowoomba, Queensland (Water)	A.	M	J. C. Ross.
Toronto	A.	AM	R. Butler.
Toronto	A.	AM	R. R. Knight.
Torpoint	S.W.	M	R. H. Beaumont.
Torquay	S.W.	M	H. A. Garrett.
Torquay	S.W.	AM	J. W. Norman.
Tottenham	E.	M	W. H. Prescott.
Tottenham	E.	AM	H. F. Wilkinson.
Tottington	N.W.	M	L. Kenyon.
Towyn	W.N.	M	R. P. Morgan.
Trincomalee	Ind.	AM	C. A. Coombs.
Tring	E.	M	S. S. Gettings.
Trowbridge	S.	M	H. G. N. Lailey.
Tullamore	I.	M	A. V. Ashe.
Tunbridge Wells	S.E.	M	W. H. Maxwell.
Tunbridge Wells	S.E.	M	W. G. Cross.
Turton	N.W.	M	V. Laithwaite.
Twickenham	E.	M	F. W. Pearce.
Twickenham	E.	M	G. R. King.
Twickenham	E.	AM	A. Wintle.
Tyldesley	N.W.	M	F. E. Jones.
Tynemouth	N.E.	M	J. F. Smillie.
Tyrone, North (County)	I.	M	F. J. Lynam.
Tyrone, South (County)	I.	M	J. W. Leebody.
Umtata, Cape Colony	Af.	M	E. J. D. Brooks.
Upper Norwood	S.E.	M	G. R. Norrish.
Urmston	N.W.	M	J. Heath.
Uttoxeter	W.M.	M	J. R. Hadfield.
Uxbridge (Rural)	E.	M	J. W. Harrison.
Uxbridge	E.	M	E. Birks.
Vancouver, British Columbia	A.	M	A. J. Henderson.
Ventnor	S.	M	H. H. Oakes.
Wakefield (County)	N.E.	M	W. E. H. Burton.
Wakefield	N.E.	M	J. P. Wakeford.
Wakefield (Rural)	N.E.	M	F. Massie.
Wakefield	N.E.	M	L. Ives.
Wallasey	N.W.	M	W. H. Travers.
Wallasey	N.W.	AM	Thomas Jones.

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TOWN.	DISTRICT.		NAME.
Wallasey	N.W.	AM	J. S. McGlashan.
Walmer	S.E.	M	H. W. Barker.
Walsall	W.M.	M	J. Taylor.
Walsall (Rural)	W.M.	M	W. P. Young.
Walsall	W.M.	AM	C. F. Nightingale.
Walsall	W.M.	AM	G. W. Teasdale.
Walsall	W.M.	AM	G. Dyke.
Waltham Cross	E.	M	W. C. Holleway.
Walthamstow	E.	M	E. Morley.
Walthamstow	E.	M	G. W. Holmes.
Walthamstow	E.	M	J. Neave.
Walton-on-Thames	S.E.	M	R. Wilds.
Wandsworth	Met.	M	P. Dodd.
Wantage (Rural)	S.	M	J. W. Harris.
Ware	E.	M	H. F. Hill.
Warminster	S.	M	C. H. Lawton.
Warrington	N.W.	M	A. M. Ker.
Warwickshire (County)	W.M.	M	J. Willmot.
Waterford (County)	I.	M	W. E. L. Duffin.
Waterloo	N.W.	M	F. S. Yates.
Watford	E.	M	D. Waterhouse.
Watford	E.	M	W. W. Newman.
Watford	E.	AM	W. Hy. Duckworth.
Wath-upon-Dearne	N.E.	M	J. H. Drew.
Wealdstone	E.	M	H. Walker.
Wellingborough	E.	M	E. Y. Harrison.
Wellington, New Zealand	A.	M	R. S. Rounthwaite.
Wellington, Salop	W.M.	AM	W. J. Goode.
Wembley	E.	M	C. R. W. Chapman.
West Bromwich	W.M.	M	A. D. Greatorex.
West Bromwich	W.M.	M	D. Ellison.
West Hartlepool	N.E.	M	N. F. Dennis.
West Hartlepool	N.E.	M	E. J. Miles.
West Hartlepool	N.E.	AM	F. Durkin.
West Norwood	S.E.	AM	C. F. Hunt.
Westminster	Met.	M	H. P. Boulnois.
Westminster	Met.	M	C. Dunscombe.
Westminster	Met.	M	E. B. Ellice-Clark.
Westminster	Met.	M	E. J. Silcock.
Westminster	Met.	M	C. Chambers-Smith.
Westminster	Met.	M	L. J. Veit.
Westminster	Met.	M	Sir A. R. Binnie.
Westminster	Met.	M	A. Ventris.
Westminster	Met.	M	T. J. Moss-Flower.
Westminster	Met.	AM	R. Blakeway-Phillips.
Westminster	Met.	AM	C. Connor.
Westminster	Met.	AM	H. M. de Colville.
Westminster	Met.	AM	G. P. Knowles.
Westminster	Met.	AM	K. G. MacDonald.
Westminster	Met.	AM	E. Thomas.
Weston-super-Mare	S.W.	M	H. A. Brown.
Weybridge	S.E.	M	J. S. Crawshaw.

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TOWN.	DISTRICT.		NAME.
Weymouth	S.W. ..	M ..	W. B. Morgan.
Whitchurch	W.M. ..	M ..	M. Sowden.
Whitehaven	N.W. ..	M ..	E. E. Stiven.
Whitehaven	N.W. ..	M ..	W. H. Beswick.
Whitehaven	N.W. ..	AM ..	A. J. McArd.
Whitley and Monkseaton ..	N.E. ..	M ..	A. J. Roussell.
Wicklow	I. ..	M ..	J. Pansing.
Widnes	N.W. ..	M ..	J. S. Sinclair.
Wigston Magna	E.M. ..	M ..	W. G. J. Clark.
Wigton (Rural)	N.W. ..	M ..	T. B. Simmons.
Willenhall	W.M. ..	M ..	T. E. Fellows.
Willenhall	W.M. ..	AM ..	H. J. Tonks.
Willesden	E. ..	M ..	O. C. Robson.
Wilmslow	N.W. ..	M ..	A. S. Cartwright.
Wilts (County)	S. ..	M ..	J. George-Powell.
Wimbledon	S.E. ..	M ..	F. Wilkinson.
Winchester	S. ..	M ..	W. V. Anderson.
Winchester (Rural)	S. ..	M ..	G. E. Carter.
Windermere	N.W. ..	M ..	C. E. Hines.
Windsor	S. ..	M ..	E. A. Stickland.
Wisbech	E. ..	M ..	E. E. Barlow.
Withington	N.W. ..	M ..	O. Hellawell.
Withington	N.W. ..	AM ..	L. Cunliffe.
Withington	N.W. ..	AM ..	H. C. Swindells.
Wokingham	S. ..	M ..	C. W. Marks.
Wolverhampton	W.M. ..	M ..	G. Green.
Wolverhampton	W.M. ..	M ..	F. G. Beaumont.
Wolverhampton	W.M. ..	M ..	R. E. W. Berrington.
Wolverhampton	W.M. ..	AM ..	E. E. W. Berrington.
Wolverhampton	W.M. ..	AM ..	W. A. Hutchings.
Wood Green	E. ..	M ..	C. H. Croxford.
Wood Green	E. ..	AM ..	R. H. Matthews.
Woodford Green	E. ..	M ..	W. Farrington.
Woodford Green	E. ..	M ..	L. J. Small.
Woodhall Spa	E. ..	M ..	E. E. T. Bolton.
Woolwich	Met. ..	M ..	J. R. Dixon.
Worcester (County)	W.M. ..	M ..	C. F. Gettings.
Worcester	W.M. ..	M ..	T. Caink.
Worcester	W.M. ..	M ..	E. Minors.
Worcester	W.M. ..	M ..	W. Ransom.
Worcester (County)	W.M. ..	AM ..	R. Fletcher.
Worcester (County) (Highways)	W.M. ..	AM ..	B. C. Hammond.
Workington	N.W. ..	M ..	H. B. Williams.
Worksop	E.M. ..	M ..	G. Rawson.
Worthing	S.E. ..	M ..	F. Roberts.
Worthing	S.E. ..	AM ..	W. H. Pearce.
Wortley (Rural)	N.E. ..	M ..	G. E. Beaumont.
Wrexham	W.N. ..	M ..	J. England.
Wrexham (Rural)	W.N. ..	M ..	J. P. Evans.
Wrexham (Rural)	W.N. ..	M ..	J. H. Edwards.
Wynberg, Cape Colony (Water)	Af. ..	M ..	H. M. Ladell.

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TOWN.	DISTRICT.		NAME.
Yeovil (Rural)	S.W. ..	M ..	L. Caplen.
Yeovil	S.W. ..	M ..	P. W. Harrison.
York	N.E. ..	M ..	R. H. Jenkins.
York	N.E. ..	M ..	F. W. Spurr.
York	N.E. ..	M ..	C. Triffitt.
York	N.E. ..	AM ..	R. H. Cousens.
York	N.E. ..	AM ..	S. M. Senior.
York	N.E. ..	AM ..	G. A. Ballard.
Yorkshire, East Riding	N.E. ..	M ..	A. Beaumont.
Yorkshire, North Riding (County)	N.E. ..	M ..	W. G. Bryning.
Yorkshire, West Riding	N.E. ..	AM ..	J. R. R. Oddy.
Zanzibar	Af. ..	M ..	G. E. L. Poulden.
Zanzibar Protectorate	Af. ..	M ..	A. R. Galbraith.

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MEMBERS OF THE ROAD SURVEYORS' ASSOCIATION OF SCOTLAND AFFILIATED TO THE INSTITUTION.

Date of Election.		
1912 Jan. 1	Allan, J.	County Road Surveyor, Huntley.
,,	Atkinson, T. R.	County Road Surveyor, Earlston, Berwickshire.
,,	Ballantine, W.	County Road Surveyor, Lauriston, Falkirk.
,,	Bartie, J.	County Road Surveyor, Selkirk.
,,	Bell, W.	County Road Surveyor, Aberfeldy.
,,	Callen, R.	County Road Surveyor, Dunoon.
,,	Callen, T.	County Road Surveyor, Haddington.
,,	Clarke, P.	County Road Surveyor, Dunbar.
,,	Clayton, A. H.	County Road Surveyor, Aboyne, Aberdeenshire.
,,	Cox, D. R.	County Road Surveyor, Stirling.
,,	Cram, P. McF.	County Road Surveyor, Nairn.
,,	Donaldson, G.	County Road Surveyor, Kirkcaldy.
,,	Drummond, R.	County Road Surveyor, Fairfield, Paisley.
,,	Ellacott, W.	County Road Surveyor, Bonnyrigg, Mid Lothian.
,,	Gibson, W. K.	County Road Surveyor, Stranraer.
,,	Goodwillie, A.	County Road Surveyor, Brechin.
,,	Goodwillie, T.	County Road Surveyor, St. Andrews.
,,	Graham, W. R.	County Road Surveyor, Hawick.
,,	Grant, A. M.	County Road Surveyor, Kingussie.
,,	Hart, A. V.	County Road Surveyor, Dumfries.
,,	Hogg, C. G.	County Road Surveyor, Dingwall.
,,	Hunter, J. M.	County Road Surveyor, Timber Green, Arbroath.

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Date of Election.		
1912 Jan. 1	KIRKLAND, J.	County Road Surveyor, Ormiston Villa, Kirknewton, Mid Lothian.
,,	KIRKPATRICK, J.	County Road Surveyor, Duns.
,,	LANG, J.	County Road Surveyor, Kilmarnock.
,,	LAPHAM, J. D.	County Road Surveyor, Linlithgow.
,,	MCBAIN, W.	County Road Surveyor, Kelso.
,,	MCGREGOR, J. M.	County Road Surveyor, Dornoch, Sutherland.
,,	MACKENZIE, J.	County Road Surveyor, Portree.
,,	MACKINTOSH, C. J. M.	County Road Surveyor, Fort William.
,,	MACRAE, K.	County Road Surveyor, Oban.
,,	PATERSON, R.	County Road Surveyor, Beattock, Lockerbie.
,,	RANKIN, J. S.	County Road Surveyor, Thornhill, Dumfries.
,,	ROBB, D. H.	County Road Surveyor, Wigtown.
,,	ROBB, J.	County Road Surveyor, Edinburgh.
,,	ROBERTON, A.	County Road Surveyor, Crieff.
,,	ROBERTON, J. B.	County Road Surveyor, Downfield, Dundee.
,,	ROBERTSON, D.	County Road Surveyor, Alford, Aberdeenshire.
,,	ROSS, D.	County Road Surveyor, Kirriemuir.
,,	SCOTT, J.	County Road Surveyor, Perth.
,,	SHIELDS, D.	District Surveyor, Fakenham, Norfolk.
,,	STORRAR, J.	County Road Surveyor, Suburban District, Edinburgh.
,,	WYLLIE, G.	County Road Surveyor, Blairgowrie.
,,	WYLLIE, W.	County Road Surveyor, Lerwick.

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STUDENTS.

Date of Election.		
1912 July 11	ADAMSON, R. A.	Town Hall, Chiswick, W.
1912 Apr. 27	ASHBY, A. W.	1 Hencroft Street, Slough, Bucks.
1912 Apr. 27	BISHOP, H. P.	Municipal Buildings, Taunton.
1912 Oct. 26	BLEAKLEY, E.	185 Elliott Street, Tyldesley.
1911 Oct. 21	BOWEN, J. S.	2 Oldbury Road, Greets Green, West Bromwich.
1912 Oct. 26	BRADLEY, H. E.	The Laurels, Merriman's Hill, Worcester.
1911 Oct. 21	BRYAN, R. C.	Chapel House, West Street, Bourne, Lincs.
1912 Mar. 2	CHANDLER, G. W.	Borough Surveyor's Office, Tewkesbury.
1911 Dec. 2	CHESTERFIELD, B. F.	Town Hall, Alton, Hants.
1912 Apr. 27	CLARKE, G. J.	Assistant Surveyor, Urban District Council, Epsom, Surrey.
1912 Sept. 9	CLIFFE, A.	Surveyor's Assistant, Urban District Council, Mexborough.
1912 June 1	CUTTING, W. A.	Gas Works, Haverhill.
1912 Apr. 27	DOXEY, H. M.	93 Rumford Street. Chorlton-on-Mersey, Manchester.
1911 Oct. 21	FITCH, J. T.	City Engineer's Office, Council House, Birmingham.
1911 Oct. 21	FLOOD, A.	88 Deansfield Road, Well Hall, Eltham, S.E.
1912 June 1	GRAVES, H. S.	Surveyor's Office, Willesborough, Ashford, Kent.
1912 Jan. 13	HARDIE, N.	57 Bradford Road, Gt. Lever, Bolton.
1911 Oct. 21	HASELDINE, W. S. T.	Buck House, Answorth, Notts.
1911 Oct. 21	HEALE, C. H. B.	St. Peter's Vicarage, Williton, Taunton.
1912 Sept. 9	HILL, J. W.	City Surveyor's Office, Wakefield.
1912 July 11	HODSON, C. F.	50 Monks Road, Lincoln.
1911 Oct. 21	HOLDEN, F. H.	26 Rossall Road, Ansdell, Lytham.

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Date of Election.		
1912 Feb. 10	Impey, L. R.	Town Hall, Sudbury, Suffolk.
1912 Jan. 13	Kershaw, Gylbert	St. Fillans, Bradford Road, Brighouse.
1912 Sept. 9	Kershaw, G...	75 Skerton Road, Old Trafford.
1912 Jan. 13	Leadbeater, H.	"New Zealand," Bridgegate, Rotherham.
1911 Dec. 2	Mason, S.	118 Stirling Street, Grimsby.
1912 Jan. 13	Moule, E. S.	Borough Engineer's Office, Town Hall, Luton.
1911 Dec. 2	North, R. W.	25 Carlton Road, Worksop.
1911 Oct. 21	Pain, W. S.	73 Penfold Road, Folkestone.
1912 Apr. 27	Piggott, A. P.	Town Hall, Stoke Newington.
1911 Oct. 21	Ponsford, G...	"The Limes," Exeter Road, Exmouth.
1911 Dec. 2	Prescott, E.	"Cavendish House," Kirkdale Lane, Leigh, Lancs.
1911 Oct. 21	Price, W. H...	Sewerage Engineer's Office, Gt. George Street, Leeds.
1912 June 1	Shaw, J. S.	Borough Engineer's Office, Wrexham.
1911 Dec. 2	Starling, L. H.	"Berton," St. Cross, Farnham, Surrey.
1911 Dec. 2	Stephens, F. B. J.	Council Offices, Bognor, Sussex.
1912 Sept. 9	Taylor, R. W.	Nelson Terrace, Unicorn Road, Portsmouth.
1912 Feb. 10	Thomson, C. B.	28 Greenhill Road, Moseley, Birmingham.
1911 Oct. 21	Tolputt, H. St. G.	"Deepdene," Brockhill Road, Saltwood, Kent.
1912 July 11	Walker, W. A.	94 High Street, Cradley Heath, Staffs.

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COMMITTEES OF THE COUNCIL, 1912-1913.

The President, Hon. Secretary and Hon. Treasurer are ex-officio Members of all Committees.

GENERAL PURPOSES.

Chairman: J. Patten Barber

Messrs.

Barber
Blair
J. A. Brodie
J. S. Brodie
Cockrill
Harpur
Hayward
Moulding
Prescott
Wakelam
Wike
Winter

FINANCE.

Chairman:
T. W. A. Hayward

Messrs.

J. S. Brodie
Bryce
Carter
Collins
Hayward
Lancashire
Maybury
Prescott
Redfern
Scorgie
Stubbs
Winter

PARLIAMENTARY.

Chairman:
A. D. Greatorex

Messrs.

J. S. Brodie
Bryce
Campbell
Carter
Collins
Greatorex
Harpur
Lancashire
Martin
Redfern
Wakelam

TOWN PLANNING.

Chairman:
J. W. Cockrill

Messrs.

J. A. Brodie
J. S. Brodie
Brownridge
Campbell
Cockrill
Greatorex
Harpur
Lancashire
Martin
Matthews
Moulding
Paton
Phillips
Redfern
Wike

STANDARDISATION.

Chairman:
E. J. Elford
Deputy Chairman:
G. F. Carter

Messrs.

Barber
J. S. Brodie
Carter
Collins
Harpur
Hayward
Martin
Paton
Scorgie
Wike
Winter

Co-opted:
E. J. Elford
E. B. B. Newton
F. W. Pearce

TRAMWAYS.

Chairman:
W. Harpur

Messrs.

J. S. Brodie
Brownridge
Cockrill
Collins
Greatorex
Harpur
Lancashire
Martin
Moulding
Stilgoe
Stubbs
Wakelam
Wike

CONSTITUTION.

Chairman:
A. H. Campbell

Messrs.

Barber
Blair
Campbell
Carter
Collins
Greatorex
Lancashire
Prescott
Scorgie
Stilgoe
Stubbs
Wakelam

ROADS.

Chairman:
H. T. Wakelam

Messrs.

J. A. Brodie
Campbell
Greatorex
Hayward
Hooley
Martin
Maybury
Moulding
Paton
Phillips
Prescott
Redfern
Scorgie
Stubbs
Wakelam
Wike

Co-opted:
J. Willmot
J. Scott

NEW OFFICES.

Chairman:
G. F. Carter

Messrs.

Barber
Carter
Hayward
Maybury
Prescott
Scorgie
Wakelam
Winter

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THE INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.

ANNUAL MEETING AT WEST BROMWICH.

July 5, 6, 7, and 8, 1911.

Held in the Institute, West Bromwich.

ALBERT D. GREATOREX, M.INST.C.E., PRESIDENT.

THE PRESIDENT'S ADDRESS.

MY first duty on taking the chair as your President is to thank the members of the Institution for the honour conferred upon me by my election to a position which has been occupied by so many distinguished engineers holding the highest appointments amongst the Municipal Corporations and Public Authorities of this country. To follow such is no easy task. Believe me, the honour is keenly appreciated, and I shall to the best of my ability not only continue my interest in the Institution, but endeavour to assist in its prosperity.

The duty which now devolves upon me of delivering to you an inaugural address, is one which increases in difficulty as the Institution grows in years. This being the first Annual Meeting under its new title, I may, perhaps, be permitted to occupy a little of your time this morning with a reference to its history and to deal briefly with the advances that have been

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made in sanitary science and that species of knowledge and practice which falls within the department of an engineer and surveyor to a local authority, during the life of the Institution under its different titles.

History of the Institution.

In the words of Mr. Lewis Angell, the history of the Institution is soon told. Engineering knowledge and sanitary science were not among the qualifications expected of the "Town Surveyor" of the last generation. The Public Health Act, 1848 called into existence another class of officers protected by the General Board of Health, under whose auspices considerable progress was made in the sanitary condition of the country. In 1858 the Public Health Act was "amended," the General Board of Health suppressed and the local surveyor handed over to the tender mercies of the omnipotent ratepayer. The consequence was that, with the exception of a few of the larger towns the office was avoided by those whose professional knowledge and character would have been of service to the country.

In the year 1868, a Royal Sanitary Commission was appointed to consider the question of consolidating and improving the sanitary legislation of the country. This commission reported in favour of the medical officer of health and sanitary inspectors being protected in the discharge of their duties. At this time the necessity of organisation by engineers and surveyors to local authorities was felt by many, and, after circularising his professional friends on the matter, Mr. Lewis Angell called the first meeting of its founders at his office at the Town Hall, Stratford, on March 11, 1871. As the result of this meeting, a conference of borough engineers, town and local board surveyors was held at the Institution of Civil Engineers on March 29, 1871, when the various matters connected with the position of local surveyors, sanitary legislation and the formation of an association were discussed. A committee was appointed to deal with the subject.

On February 15, 1873, a general meeting of local surveyors was held at the Institution of Civil Engineers for the formation of an Association, when a resolution was unanimously adopted "That an Association be formed for the promotion of the

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professional interests of its members and of that branch of sanitary science which falls within their official duties."

A meeting of local surveyors in the Midland District was subsequently held in Birmingham on April 19, 1873, when the proceedings of the meeting in London were approved and adopted. On May 2, 1873, the inaugural meeting was held at the Institution of Civil Engineers, and largely attended. The early title was "The Association of Municipal and Sanitary Engineers and Surveyors," and Mr. Lewis Angell was elected first President, a position to which he was justly entitled, as it was to his untiring industry and energy that it was founded. The objects of the Association were "the promotion and interchange among its members of that species of knowledge and practice which falls within the department of an engineer and surveyor engaged in the discharge of duties imposed by the Public Health, Local Government, and other Sanitary Acts, and the promotion of the professional interests of the members and the general promotion of the objects of sanitary science.

The objects were, therefore, not to advance any new theory, or settle vexed questions, but its legitimate work was then, as it is to-day, rather to ventilate existing practice, by affording its members, scattered as they are in official positions throughout the country, the opportunities of meeting to compare notes, discuss principles, and inspect works, and thus be better able to fulfil the duties of their respective positions to the advantage very largely of those in whose service they were and the general benefit of the public.

The first Annual Meeting was held in Birmingham in the year 1874, during the mayoralty of Alderman Joseph Chamberlain, and at the end of the first year the membership was 160.

In the year 1890, in order to strengthen its position and improve its status, the Association was registered under the Companies Act and the title changed to that of "The Incorporated Association of Municipal and County Engineers."

It is interesting to note that during the 38 years of the existence of the Institution, 271 meetings have been held and 629 papers submitted for discussion on almost every subject of interest to members of the profession.

Some subjects have naturally been referred to on many occasions, such as the sewage problem, road construction and maintenance, the vexed question of sewer ventilation and many

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others, and much valuable and useful information has been contributed for the use of its members, and consequently of considerable value to the general public.

One agreeable feature in connection with these meetings has been the cordial recognition and hospitality shown to the Institution by municipal authorities at the various towns in which they have been held, an evidence that the official functions of the members are fully appreciated.

In reviewing the past, the Institution is to be congratulated upon the work accomplished from time to time, and we look forward by the renewed energy of the Council, supported by the general body of its members, on the work still to be undertaken.

Under the change of title and constitution, it is to be hoped that succeeding years will show a greater increased membership. There are many who should join its ranks, but, at the same time, the standard of qualification must be maintained, and no one should be accepted to full membership unless he has thoroughly proved himself to be a fit person to undertake the work which the membership of such an Institution appears to guarantee.

The Local Government Board.

My notes as to the past would not be complete without some reference to the formation of the Local Government Board, which was constituted by the Local Government Board Act of 1871, in pursuance of recommendations of the Royal Sanitary Commission appointed in 1868–9.

The Commissioners had called public attention to the congestion which existed in the domain of local government, owing to the want of uniformity in central control. Poor Law matters were under the jurisdiction of the Poor Law Board. General questions of Local Government were referred to the Home Office. Measures for the prevention of disease were within the sphere of the Privy Council. Schemes for water supply were dealt with by both the Home Office and the Board of Trade.

Under the Act of 1871, the Local Government Board took over all the powers and duties of the Poor Law Board and those of the Home Office and Privy Council relating to Public Health, Local Government, and other matters.

Since 1871 numerous additional powers and duties have

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been transferred from other Departments to the Local Government Board, or vested in that body under fresh legislation.

The Public Health Act, 1875, enormously increased its functions and general control of sanitary authorities, and many other statutes, too numerous to specify here.

The Local Government Board has now become a huge department of State, in no way inferior in influence and responsibility to the older departments; and Municipal Engineers, who are particularly interested in this department, heard with great satisfaction that its chief, the Right Hon. John Burns, M.P., was to enjoy the same status as other Cabinet Ministers.

The total amount of the loans which were sanctioned by the General Board of Health under the Public Health Act, 1848, up to the 1st September, 1858, when the Local Government Act, 1858, came into force, was £2,956,178.

The sanctions granted by the Secretary of State under the latter Act, and the Sewage Utilisation Act, 1865, prior to the 19th August, 1871, amounted to £7,363,366.

Since the constitution of the Local Government Board on the 19th August, 1871, they have sanctioned the borrowing by urban and rural authorities to the year 1909 of no less a sum than £190,515,467.

Of course, during the period covered by the above figure, the powers and duties of these authorities have been very largely extended. The objects for which money can be legally borrowed are consequently more numerous and varied than formerly; but, even now, a large proportion of the schemes submitted to the Local Government Board, with applications for their sanction to loans, relate to matters connected with the public health.

These figures are given to show the great increase in the sanitary and other work executed in the country during the last forty years by municipal authorities, and members of this Institution can rightly claim to have been responsible for the designing and carrying out of a very large percentage of these undertakings.

Sewage Disposal.

The importance attaching to the efficient disposal of sewage cannot be over-estimated, and its suitable treatment has played

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for very many years an all-important part in public health matters.

At the commencement of the history of the Institution, cesspools were still in vogue in many parts of the country, although the sewage from the larger masses of the population was carried by more or less perfect systems of sewers, for discharge into streams or occasionally into the sea.

Owing to the more stringent requirements of the Rivers Pollution Act of 1876, steps had to be taken in all sanitary districts to prevent the fouling of rivers and streams by providing a system of sewage treatment.

The use of sewage as manure having been at first considered the most sanitary and satisfactory method of disposal, the early attempts of dealing with water-carried sewage were in the direction of sewage farms and land irrigation, but, in time, it became impossible to find for the larger cities areas of land at reasonable cost, and trouble arose from various causes.

It therefore became necessary to adopt other means for dealing with the sewage. Purification by precipitation, with the aid of various chemicals and other processes, came into operation, and vast sums were spent in constructing settling tanks and other works for this purpose.

In the year 1887, Mr. Dibdin pointed out that, without the intervention of living organisms, no material destruction of the complex bodies existing in sewage could take place. Following the publication of these views, the State Board of Health of Massachusetts commenced their series of elaborately conducted experiments in November of the same year, and during the years 1888, 1889 and 1890 obtained very valuable results.

Valuable as were these results, they still left the question in an all but impracticable form, as the quantity of sewage treated was so small. It therefore became necessary that precise data on a working scale should be obtained, and with this object, the Main Drainage Committee of the London County Council instituted a series of experiments at their Outfall Works with most successful results.

At the same time, the Sutton (Surrey) Local Board, acting on the advice of Mr. Dibdin (Chairman of the Sewage Committee), carried out a series of experiments on similar lines. These experiments worked with great success, and thus encouraged, the newly-formed district council finally converted

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their existing precipitating system into a bacterial one. Thereafter numerous installations were put into action, which embodied in one form or other, the principles of the Sutton Works, either as regards the coarse beds, or the fine beds for effluent, and the process spread with remarkable rapidity.

Then followed the introduction, by Mr. David Cameron, City Engineer of Exeter, of septic tanks, while at a later period percolating filters were introduced. The methods of distributing the sewage upon these filters are so numerous and varied that it is impossible to refer to them in detail in this address.

So important had this subject become in 1898, that a Royal Commission was appointed to inquire and report as to what methods of treating sewage might properly be adopted. The labours of this Commission are not yet completed; no less than five reports have been published, with voluminous appendices, and much valuable information, has, as a result, been communicated.

Abundant statistics are now to hand showing, by the results of chemical and biological examination, the extraordinary degree and regularity of purification which is effected by modern "bacterial" methods.

There is further evidence of the success of this system in the fact that the effluent, when kept at summer heat, either naturally or in an incubator, does not undergo offensive change and can accordingly never cause a nuisance either by itself or when discharged into a watercourse, and it is gratifying to know that, as pioneers in the scientific and constructive branches of the most important developments in the treatment of sewage, members of this Institution have taken an important share of the work.

Tramways.

When the Tramway Act of 1870 was passed, horses only were to be employed, except with special consent of the Board of Trade and local authorities. To safeguard the surface of the road, stringent provisions were made for maintenance of the part affected, at the cost of the tramway proprietor. Above all, the wisdom of Parliament was shown in the decisions given

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upon the warmly debated points of a road monopoly and rental for its grant.

In 1879, steam traction became a commercial factor in the consideration of tramways, notwithstanding the fact that the enemies of tramways were loud in their cries of public danger. After due time, steam traction was condemned, not on grounds of public safety, but on grounds of public comfort and convenience, and for want of economy, direct and indirect. Still, steam traction bridged a period of transition. It first made provincial tramways a necessity. With steam tramways came penny fares, and with penny fares the town population began to travel towards the outskirts of towns. Wise and progressive municipalities gained courage to frame improvement schemes and to clear slums, the population of which moved one stage higher to the cottages vacated by the artisan, who, by a penny tram ride, had first learned that the luxuries of fresh air and garden ground were within his means and reach; so, with popular appreciation, tramway traffic increased by leaps and bounds.

Then came a change; the broad principle was enunciated by a leading American engineer that the production of tractive power upon the roads, in the crude form of horses or steam engines, was a scientific error, as well as a public nuisance and that all the power required for the traction of any cars upon a route might be obtained with economy and efficiency from a central generative station, and then conveyed along the roads by means of a continuous steel rope or cable.

Ridiculed at first, this view had speedy and powerful support in the United States; San Francisco and Chicago proved the advantages of cable traction.

Melbourne quickly followed American example, and the year 1888 saw the adoption of the cable system of traction upon lines in England and Scotland, at Highgate, Birmingham, and Edinburgh.

Results, both in the increase of traffic and decrease of cost of traction, proved the advantages of this form of traction, but they made no further headway in Great Britain, the cost of the reconstruction and equipment of this system no doubt to a great extent, being the cause.

About this period came rumours from America of the adoption of yet another form of traction, said to combine all the

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advantages and economy of cable traction at one third the cost of installation, namely, by the use of electricity. The rapidity with which this system spread over America caused tramway companies in this country to look seriously into the matter. Municipal authorities, however, refused to consider the introduction of overhead wires along the streets of their districts.

Up to 1890, the general use of overhead systems in Great Britain appeared to be improbable. Municipal authorities flatly refused to permit the "bird cage" system of construction which American engineers stated to be essential to the use of an overhead system. An English engineer, however, solved the difficulty which American engineers stated to be insuperable. With this invention, which was speedily brought into practical use, the necessity for the use of the "bird cage" was at an end, and the objections of municipal authorities to the overhead system, were, in great measure, removed. So, gradually, the conviction was brought home to all impartial persons interested in tramways, that a simple, convenient and economical solution of a vexed question had been discovered and that tramways would become a sound investment as well as a great public convenience.

Time will not permit for reference to be made to many other systems which have been tried from time to time, such as compressed air, oil, gas and electric accumulators, conduit and surface contact systems.

The expiration of the companies' leases and the adoption of this system having been proved to be on sound lines, no branch of municipal enterprise has made more rapid progress during recent years than that relating to tramways. Almost without exception, every large town has completely municipalised and electrically equipped the undertaking, or permitted companies to do so, and thus the introduction of new methods of traction and facilities for rapid transit in our great centres of population, have been completely revolutionised.

One of the earliest electric tramway systems constructed in this country was the line opened by the South Staffordshire Tramway Co. in 1893, in the neighbouring town of Wednesbury, which Members had an opportunity of seeing at the annual meeting held under the presidency of my predecessor, Mr. J. T. Eayrs.

The latest development is that known as the rail-less trolly

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system, which appears to be acquiring considerable popularity, and no doubt the success of several Corporations in obtaining the sanction of Parliament to their schemes will lead many other enterprising municipalities to follow in the same direction.

The pioneers in this country are the Leeds and Bradford Corporations, their undertakings being opened on June 22nd last.

The share that municipal engineers have taken in this work, not only in the construction of the permanent way of tramways, but in the question of the standardisation of rails, and the subject of rail corrugations, justifies my reference to the subject in this Address.

Highway Construction and Maintenance.

By the Highway Act of 1835, the repair of highways (but not of turnpike roads) was placed under the care of Surveyors of Highways.

By the Highway Acts of 1862 and 1864, highway districts could be formed and governed by a highway board. Such highway boards were invested with all the powers and duties of the surveyors of highways within any parish forming part of such district. These highway districts took the place of districts formed under the Act of 1835.

The Public Health Act of 1875 divided the country into urban and rural sanitary districts, under the control of urban and rural sanitary authorities. Urban sanitary authorities were invested with all the powers and duties of surveyors of highways within their respective urban sanitary districts.

The Highways and Locomotives (Amendment) Act, 1878, with a view to uniformity, provided that highway districts should be formed in future so as to be as far as possible coterminous with the rural sanitary districts and where this was carried out, the rural sanitary authority became the highway authority, with the powers and duties of a highway board.

By the Local Government Act, 1888, county councils and county borough councils were invested with the powers, etc., of highway boards in regard to main roads.

By the Local Government Act, 1894, the powers, etc., of highway boards and of surveyors of highways in highway parishes, were transferred to the rural district councils that

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took the place of the rural sanitary authorities, and the area of the rural district became the highway area.

I have thus briefly shown the important changes that have taken place in highway legislation since the Highway Act of 1835.

"Good roads constitute the basis of national prosperity," said Sir George Gibb at the Brussels International Road Congress last year. They are also necessary to develop the natural resources and manufactures of a country, which can only be done by communication between towns and rural districts.

The evolution of the modern road can only be adequately understood by reference to the practice of this interesting subject, from the time of the making of the great military roads of the Romans to the present time, authentic descriptions of which are recorded.

The introduction of the self-propelled vehicles, popularised by the facilities granted by law for quick travelling on the public roads, has established a new epoch in the history of highway construction, old methods, ideas and traditions in every sphere of work have inevitably to give way to new ones, not because they were unsatisfactory in the past, but because they are inadequate to satisfy present and future requirements.

It is well to note the opinions of the user of the roads as well as the maker. In recent years the former individual has not failed to make known his complaints, yet he has not always been ready to give an intelligent or possible remedy for defects. But mechanical haulage has made both the user and the maker change their views on many points and there is more desire to help in a solution of real difficulties than simply to "slam" one another because these things exist.

The advent of the motor car is undoubtedly responsible for the radical changes which have been found necessary, in methods of construction and maintenance of roads. The motor has come to stay, and must, therefore, be thought of when we are considering this question.

It is now recognised by road engineers that the principal weakness of a water-bound macadam road, under the present conditions, when ponderous loads have to be carried and disintegrating vibrations are caused, especially by the quick passage of self-propelled vehicles, is, its inability to prevent movement

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between the macadam. However slight this movement may be, friction takes place, and the stones are ground against each other, producing dust or mud. This internal attrition increases in wet weather in proportion to the magnitude and character of the traffic, whilst in dry weather the mud-binder is worked out of the interstices by vibration, and the stresses applied, with the result that the road is pulverised and rapidly disintegrated.

I cannot leave this subject without referring to the Heavy Motor Car Order of 1904, which does not, in my opinion, receive the attention it should, for in very few instances is this order enforced. No doubt before long a charge will be made on all steam vehicles, probably on the basis of so much per ton of axle weight per annum. It will then be necessary to see that this allowed axle weight is not overstepped. At any rate, it is not likely that the motor-driven vehicle owner, using taxed fuel and running legally, will long put up with the anomaly of its heavier brother, using an untaxed fuel and unlimited axle weight, running on roads supported and improved by the finances resulting from the tax provided by the lighter and less damaging motor vehicle.

The proposals of the Road Board for the improvement of the roads in this country, as well as the enormous increase in traction engine and motor traffic in recent years, the question of new trunk roads for quick traffic, and similar suggestions, are subjects which require the careful consideration of all interested in our roads, and they should be considered in that broad spirit which their importance demands.

It is a matter of great satisfaction that in the appointment of an Advisory Committee to the Road Board, members of this Institution have been selected to fill this important office, and it is also satisfactory to note that municipal engineers who are studying the question of improved roads in this country are still to the front.

The appointment of the Road Board, the meetings of Road Congresses and Conferences at home and abroad, indicate the importance of and the great interest taken in the problem of the highways, and, when the Third International Congress on Roads is held in London in the year 1913, it is to be hoped that many of you will take a prominent part.

In view of the great importance of this subject, the Council

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have lately appointed a special committee to deal with all questions in connection with roads and their maintenance, and there is no body of professional men better able to undertake the necessary experimental and scientific investigations than municipal and county engineers.

Building By-Laws.

Most of the building operations in the country are conducted under Building By-laws framed by powers provided by the Public Health Act, 1875.

The Act was definite upon certain material points, but, with regard to most building matters, it provided that they should be regulated by by-laws, which it was optional for local authorities to adopt or not, though the sanction of the Local Government Board was necessary before they could become effective. Before very long, the Board drew up a model series of such by-laws and the various local authorities were supplied with these and invited to adopt them rather than to frame their own. At first, this action was greatly resented in many quarters, but, in the course of years, its wisdom has been recognised, and now there are not many parts of the country where the model by-laws, with but slight modifications due to the exigencies of locality, are not in force, at any rate, as far as regards the most material provisions.

This Institution has, for many years, given to this subject a considerable amount of time, but it is satisfactory to know that the Local Government Board are prepared to consider any suggestion that may be made by municipal engineers for the improvement of the building by-laws of the country.

I suggest that the present building by-laws should be remodelled or a universal Building Act adopted, which should be compulsory and power should be given to each district, subject to the Local Government Board, to frame regulations as to the minimum size and strength of material to be used in the construction of buildings, drainage and other particulars. They should be concise, deal consecutively with the various subjects, follow the same order in which they usually have to be dealt with in building operations, be provided with a full index, marginal notes, explanatory illustrations and diagrams.

In framing these regulations, greater latitude should be

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given to each district, making them vary according to the requirements of each particular district. They would not then be so cumbersome and unnecessarily lengthy. At the same time, definite rules should be laid down, as it would be dangerous to make them too elastic, or they would not be properly enforced.

Power should also be given to charge fees for the supervision of all buildings, on the same lines as is done in London under their building Acts and several other towns under private Acts.

Time only prevents me from indicating still further the process of evolution in sanitary practice and the many and varied duties of a municipal engineer, but I venture to hope that the brief outlines indicated will appeal to the imagination of those present, stimulate their untiring energy and be an incentive to fit themselves, by the aid of this useful Institution, to carry on the work of progress.

Past, Present, and Future of the Institution and its Members.

I have endeavoured to show how, through the influence of this Institution in the past, the status of the Members has improved, and by the brief digest of the advancements made in some of the most important branches of a municipal engineer's work, the great changes which have been constantly taking place and, at the same time, how the municipal engineer has always been alive to such changes and the responsibility of these added duties. The only cause for regret is that, notwithstanding these changes and added responsibilities, the emoluments of the office have not made the same progress. The salaries paid to-day by many local authorities is, to say the least, a disgrace to such authorities, and it is to be hoped that, with the assistance of this Institution, a more enlightened policy will be pursued in this respect in the future.

The town surveyor of the present day is a far different individual from those who held office under the authorities when the town surveyor was first legalised by the Towns Improvement Clauses Act of 1847. He must now be a competent civil engineer of great knowledge and varied experience, for he may, at any moment, be called upon to advise his Council on almost every conceivable subject.

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It may be that, in the not far distant future, some of you may be called upon to construct "aerodromes" or other buildings for the housing of "dirigible" balloons, or to erect steel or reinforced concrete platforms or stations for the conveniences of passengers in connection with the daily service of "aeroplanes" or other means of rapid transit from not only town to town, but country to country, or to assist in the development of a supply of heated and pure air for warming and ventilating our homes, from a central distributing station. When this time comes, may you prove yourselves ready for any emergency.

So much for the past and present; now as regards the future of the Institution.

In the British Isles, there are at least two thousand local authorities, employing engineers and surveyors in charge of the construction and maintenance of engineering and other works, and it would be well if not only these officials, but those who are assisting them in their many and various duties, as well as those who are being trained to occupy those positions at some distant date, became members, in some degree or other, of this Institution; for no one can ignore the fact, which is patent to the mind of every member, of the advantages which, of necessity, arise from co-operation and mutual support.

The meetings which have been held in various parts of the country have been the means of bringing together, with one common object, men who, but for these meetings, would have been strangers to one another, working on in their own little circle and missing that interchange of thought which has tended so much to develop resources which would otherwise have been dormant and unused.

No doubt, owing very largely to the influence of this and kindred institutions, higher aspirations in sanitary and other matters now obtain with the public than did formerly.

It is to the interest of the health and lives of the public that these aspirations should not only be satisfied, but their further growth encouraged. This can only be done successfully by our being ever ready with up-to-date knowledge, and there is no possible way of gaining that knowledge better than afforded by such institutions and meetings, the conferences arranged under their auspices, where opinions are freely exchanged and all recently acquired information made public.

The Association of Municipal and County Engineers was

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for years criticised as being under a reactionary administration. Changes have been brought about in its constitution of a far-reaching character, which will, it is to be hoped, be to the increased prosperity and usefulness of the Institution and its members.

These changes have been made after very careful consideration, and I should here like to pay a tribute of appreciation to the care and able management of the affairs of the Institution by the older members of the Council.

The question is, how are the interests and well-being of the profession to be considered in the future. I claim to be sufficiently courageous to venture to suggest that the interests of our profession will be best served by the formation of a united institution formed on broad-minded lines, instead of there being two or even more institutions of a similar character having practically the same objects in view. The point to be considered is, how to bring about the desired effect. A suggestion has already been made that the two institutions of almost similar name should be united. Should this subject be introduced to the Council, it will, I am sure, be considered with the same care and attention as that given to the other important proposals, having in view the greatest benefit to the profession as a whole, and at the same time maintaining the status of the profession.

Now a word to the younger Members of the Institution and those qualifying for positions in the future in the municipal engineering world.

The young engineer now has many opportunities for obtaining knowledge in the teaching given in the universities and the technical schools of this country and they should take full advantage of these classes. They should also take every opportunity of viewing engineering works of a municipal character while in course of construction, and afterwards when in full work, and thus become masters of the subject in all its details. Further, to educate yourself as an engineer, write and read a paper upon some subject of which you have made a special study and take part when opportunity occurs, in the discussions. This will materially assist you in your progress in the profession, and will give you that confidence so necessary to all. The Council offer premiums for the best papers submitted during each session. This should be some inducement

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to those who are able to submit papers on subjects of interest to the Members of the Institution.

To the readers of papers, I would offer the following advice. Make the papers short, and draw conclusions at the finish, so as to form the basis of the discussion. By this means much more interesting discussions will ensue, and information of service will be more likely to be forthcoming for the benefit of the Members as a whole.

Another matter of value to the Members is in reference to the large number of queries sent out from time to time on almost every subject. If these queries were first communicated to the Secretary and issued by him, I feel they would be of more value, and would in many cases save much valuable time to those seeking for information, and could be so arranged as to be of great assistance to the whole of the Members, and would prevent information being given that is sometimes used by the wrong persons, and I fear, not always for its legitimate use.

Town Planning.

The great importance of this question and the responsibility devolving upon the municipal engineer in regard thereto justified the Council in arranging a Conference as part of this Annual Meeting. The response to this has been very gratifying.

I do not in this Address propose to deal with the subject of Town Planning, as it is my intention to make a few observations on the subject at the opening of the Conference this afternoon.

Orphan Fund.

No apology is necessary in once more directing your attention to the Orphan Fund, which is deserving of far more support than it receives.

Since it was established in 1899, under the presidency of Mr. O. Claude Robson, who has devoted so much time to this very useful fund, the benefits have been apparent to many. It has performed a very useful service. Still, the fund does not make that progress it should, and I do urge upon especially the younger Members of the Institution to give it not only sympathy, but support.

When the District Committees are formed, one of the first

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and most useful functions they could undertake would be to endeavour to obtain from every Member in that District an annual subscription, however small.

Superannuation and Security of Tenure.

That all-important question to many of you, Superannuation and Security of Tenure, has been referred to in preceding addresses, but I claim your indulgence in making brief reference once more to such an important matter.

Before the formation of this Institution, no less than thirty-nine years ago, this subject was one of the first matters dealt with, for I find that in the year 1872, when the Government was promoting, as a result of the report of the Royal Sanitary Commission already referred to, a Bill dealing with sanitary matters, a conference of civil engineers and surveyors holding office under the various local sanitary authorities in England and Wales, was held at the Institution of Civil Engineers, on February 8, 1872, for the purpose of submitting a memorial to the President of the Local Government Board, having for its object the desire of recognition by the Government and the inclusion in that Bill of such a provision as would give security of tenure to surveyors as well as to other officers. Unfortunately this object was not accomplished.

There can be no doubt that the claims are much stronger to-day than in the past. Superannuation is a concession, the justice of which can scarcely be seriously controverted, but local authorities have always been jealous of any interference with what they call their control over their officers and servants, even though that control not infrequently takes the form of harsh and unjust treatment, especially in the case of officers whose duties, when fearlessly and conscientiously discharged, bring them into collision with local vested interests, a state of affairs which is particularly liable to occur among the smaller authorities.

Reference to the Annual Report of the Council will show how the question of superannuation stands at the present, but I am strongly of opinion that efforts should be made first of all to obtain security of tenure and then there is no doubt that superannuation would quickly follow as a natural sequence.

> "Others, it may be, if not we,
> The issue of our toil shall see."

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In conclusion, I regret the time at my disposal has compelled me to make my Address shorter than I should have otherwise wished, and has not allowed me to deal with many matters with the care they deserve, nor to refer to many subjects with which the engineer and surveyor to a local authority has to deal; but my desire is not to occupy too much of your time, knowing how very important are the subjects to be discussed at this meeting and how necessary it is, in order to get through the business of the meeting and the Conference on so important a subject as "Town Planning," which has for its main object the better housing of the people and the improvement of our towns, that too much time must not be taken up by myself.

I desire to place on record my appreciation of the services rendered to the Institution by our esteemed secretary, Mr. Thos. Cole, who, for thirty years, has faithfully discharged the duties of his office in every sphere; also to the assistant secretary, Mr. H. A. Giles, for so ably assisting his chief by that loyalty and devotion so necessary between those in office.

Gentlemen, I give you a hearty welcome to West Bromwich, and trust that the arrangements made for the meeting will meet with your approval, and that the time spent here may be both profitable and enjoyable to you all. I can assure you that I will, to the best of my ability, endeavour to faithfully discharge the duties of the position to which you have this day been pleased to elect me, and again tender my best thanks for the honour not only conferred upon myself, but for the second time, upon the town which I have the privilege to represent.

A vote of thanks was unanimously accorded to the President for his Address.

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NOTES ON STREET LIGHTING FROM A PRACTICAL POINT OF VIEW.

By H. E. COPP,
Borough Gas Engineer, West Bromwich.

The subject, at any rate as regards the first portion of its title, is doubtless a somewhat hackneyed one. Of recent years there have been numberless communications to the press and to technical societies dealing with street lighting. They are for the most part written for the purpose of advocating one or another particular form of illumination in which the writer is especially interested. In the present instance, however, the Author proposes to set down in plain language, and with the avoidance of all technicalities and refinements of doubtful utility, a few points which have come under his personal notice, in the hope that some of your members who are responsible for public lighting in the towns they represent may find some further points of interest in the subject, the importance of which deserves more critical consideration than it has hitherto been accorded. The fact that in most of the towns no standard of lighting is recognised (some spots being lighted most extravagantly, and others left in almost complete darkness, a remark which applies in some cases to whole districts), is in itself a sufficient justification for bringing the matter to the further notice of the members of your institution. The Author would, therefore, endeavour to present in an impartial manner a general review of the subject in its present state of development.

The communications referred to, which have for their sole object the advertisement of one particular system of lighting, seldom have any technical value, as it requires an expert to discriminate between truth and fiction. Only recently a technical journal devoted a whole issue to a studied rodomontade on the subject of its rival illuminant for street lighting purposes, which contained many misrepresentations and

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photographs of street lighting, which could only serve to illustrate the skill or patience of the photographer; indeed a reader without technical knowledge would at least expect the condemned system to be supplanted forthwith. Such methods cannot be regarded seriously, and do little or nothing to advance knowledge of the subject under consideration. On the other hand, a paper was read before the Institution of Gas Engineers in June last by Mr. Jacques Abady, of London, which treats of the subject of public lighting by both gas and electricity in a most able and impartial manner, and must have exercised a sobering influence on partisans of both systems.

The standard of lighting must necessarily vary in different towns. It would be absurd to adopt the same standard of lighting, say in some parts of London where public thoroughfares are congested with heavy traffic, as in a small country town. It must be borne in mind, however, that two kinds of lighting are required; the one strictly utilitarian, and the other extravagant, such as would be deemed necessary for certain localities and places of resort as a species of advertisement in seaside towns, watering places, and the like. In the present instance, however, the Author proposes to deal more particularly with the former phase of the question, from which it would seem that the standard to be adopted in any town or locality should bear some relationship to its rateable value per head of population.

A keen competition is at present in progress in London between gas and electricity for public lighting, which can only result in great improvements in the application of both systems of lighting, but probably at considerable cost to the community, as a standard of lighting is being established which in some cases exceeds the public requirements. An instance of this will be found in the lighting of Victoria Street, Westminster, which is lighted by high pressure gas, the average illuminating power of the lamps being 3274 candles, while in other places lavish grouping of flame arc lamps will be found. In Marylebone, there is an example of what can be done, on a more moderate scale, with metallic filament lamps, there being over 2000 in use. But in spite of this competition, it is certain that both gas and electricity will continue to be used for street lighting for many years to come, and advances of one system will be met by corresponding advances of its rival. It is well

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known that in Germany great progress has been made in the science of public lighting in recent years, and perhaps a higher standard has been established in Berlin than in any other city, but notwithstanding the enormous increase in the uses of electricity, the municipal authority is annually spending over 50,000*l.* on the improvement of its public lighting by gas alone.

The essential conditions for satisfactory street lighting are (1) even illumination of the ground, or objects near the ground; (2) uniformity of colour; (3) absence of glare. In order to fulfil the first condition, the lights must be placed at a height above the pavement corresponding with their power and spacing. A great objection to large units of light is that they must be fixed so high above the pavement that the light shines directly in the first floor windows. As regards the second condition, looking along a street there is nothing more distressing to the eye than a marked diversity in the colour of the lights in a business thoroughfare. Such diversity must constitute a positive disadvantage to shopkeepers, as it would nullify to some extent their own efforts in this direction. With regard to the third condition, it is to be regretted that "glare" is often preferred to good illumination, and indeed is regarded by the average individual as such. Ideal street illumination would be by reflected light only, with the source of light invisible to the eye; in practice, however, such a system would be prohibitively costly, but every one knows how much better an object may be viewed when looking away from the sun than when looking towards it. The spectacular effect of a theatrical scene would be ruined were not the lights carefully screened from the eyes of the audience.

Spacing of Lamps.

In modernising the lighting of a district, and having decided on the power of the lamps to be installed, the better plan is to re-arrange the spacing of the lamp posts. On account of the low first cost, however, there is a strong temptation to fix two or three burners in the lanterns instead; this is usually an unsatisfactory arrangement, as the lamp posts will probably be too low for the proper distribution of light: "the greater candle power of the lamp, the higher it should be placed," may be regarded as a general axiom. For instance, if the low standard

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of a minimum illumination of 0·1 candle foot were required, and the lamps were 50 yards apart, and 12 feet high, a unit of no less than 1850 c.p. would be necessary, whereas, if the lamps were 20 feet high, 1200 candle power only would suffice. On the other hand, if the lamp posts were 30 yards apart, 400 c.p. would be required if fixed at a height of 12 feet, and 300 c.p. if 20 feet. In other words, for even distribution of light, the rays from two adjacent lamps should intersect at the ground level when about 15 degrees below horizontal. If this rule is followed, contrasts in the degree of lighting which are such a source of danger to traffic, will be avoided, and there will be a minimum waste of light and a maximum of efficiency. In rural districts the angle may be reduced to 10 degrees below horizontal.

The following is a portion of a table given by Mr. J. Abady in his paper, to which reference has already been made, and will be found to be an extremely useful guide.

Height of lamp: feet.	Distance apart Ten degrees intersecting.	Distance apart Fifteen degrees intersecting.
12	136	90
15	170	112
20	227	150

It may be here mentioned that centre lighting is generally regarded as preferable to side lighting, but this system can only be utilised in comparatively narrow streets; an experimental installation will be found in Cannon Street, E.C. Apparatus for suspending both gas and electric lamps centrally is manufactured by the London Electric Firm, of Croydon.

Choice of Lights: Upright *v.* Inverted Burners.

During the past three years, the inverted burner has largely supplanted the upright burner for street lighting; the reason for this being, that the former gives a much higher efficiency than the latter, and is less costly in maintenance. The upright burner gives its maximum light at an angle between 15 degrees and 20 degrees above horizontal, whereas the inverted burner gives its maximum light about 45 degrees below horizontal. The chief reason for the greater efficiency of the latter is that the burner is to some extent regenerative, the injected air and gas being more or less heated before reaching the point of combustion. This increased efficiency more than compensates for

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the proportion of light lost through being emitted in the wrong direction. The Author has designed a lamp in which an attempt is made to utilise the misdirected rays from an inverted burner, and redirect them where they are required, *i.e.* along the road about 15 degrees below horizontal. A sectional drawing of the lamp (Fig. 1) and polar curves of the lighting effects under different conditions (Fig. 2) will be found at the end of the paper. It will be seen that the burner used throughout the tests was not a particularly efficient one, but the comparative values of the tests are not thereby vitiated. The chief features of the lamp are as follows:—(1) The top of the lamp is hinged, and can be swung back to facilitate cleaning. (2) Reflectors are fitted at the top and bottom of the lamp, in both of which a reflection of the mantle can be observed when viewed at an angle of 15 degrees below horizontal. (3) The burner is attached to the top of the lamp, and is consequently removed with it, whereas the mantle is protected from wind, while the inner and outer glasses are cleaned in turn. It will be noticed that there is no circulation of air between the inner and outer glasses, so that the annular space is practically dust proof, a feature which is utilised in a manner which is described hereafter.

Reflectors.

Electric lamps possess the great advantage over gas that reflectors of almost any type can be utilised. Holophane globes have long been used in connection with the former, but are generally inapplicable to the latter. These globes consist of a series of glass prisms for the purpose of refracting and distributing the light. Mr. Jaques Abady found that the "Excello" flame arc lamp, which is fitted with a dioptric globe, gave an almost ideal curve of illumination, and it occurred to the Author to introduce a plate of prismatic glass between the inner and outer glass cylinders of the gas lamp previously referred to for the purpose of refracting the rays of light from the bottom of the mantle in the desired direction. A reference to Fig. 2, curve No. 6, plainly shows the advantage obtained by this simple arrangement. It can only be applied, however, where the refractor is absolutely protected from dust. The top reflectors of a lamp fitted with inverted burners should always

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be conical or convexed in shape; some manufacturers have made the error of adopting a concave reflector.

Lighting in West Bromwich.

Although West Bromwich cannot be considered a criterion as regards public lighting (the cost of which is borne chiefly by the gas department, the gas being charged at considerably less than cost price), nevertheless examples of almost every modern system will be found in the town. Experiments with high-pressure gas lighting were conducted as long ago as in 1903; indeed, to West Bromwich belongs the distinction of possessing one of the first, if not the first public lighting installation on this system. It was, however, eventually abandoned as being unsuitable for the requirements then existing. The installation, on what was known as the "millennium" system, consisted of an electrically driven compressor, in which the gas pressure was raised to 10 inches water column. The lamps each contained one upright burner, consuming 20 cubic feet per hour and giving a nominal light of 800 candles.

A further system was tried in another portion of the town, in which air was used at a pressure of 2 lbs. per square inch, by means of which the gas was injected through an annular space in the nipple, upright burners being used. The system was kept at work for some three years with fairly satisfactory results, but was replaced on the advent of high efficiency multiple inverted burner low pressure lamps. From experiments he has made, the Author is of opinion that very high efficiencies can be obtained with suitable inverted burners and highly superheated compressed air.

Mention must also be made of the arc lighting in High Street. This is an example of unfortunate disposition of lamps. The tram poles are too close together to permit of the use of two lamps on each pole, and too far apart to give a good distribution of light as fixed on every alternate pole, whereas if only one lamp per pole had been used it must have been fixed on the top of the pole, and would consequently be too high for practical purposes.

Examples of modern high-pressure inverted gas lamps, working at a pressure of 2 lbs. per square inch, will also be found in St. Michael's Street. These lamps are fitted with

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automatic lighters by means of which any number can be turned on or off at will. These lamps are of the Keith type, similar to those in use at Westminster. The Author has found them to give an efficiency of 55 candles per cubic foot of gas per hour, when tested at a range of 15 feet and 20 degrees below horizontal with West Bromwich gas (which averages 16·5 candles, No. 1 Standard Burner, and 620 B.Th.U.); but when using gas of a lower grade, such as that supplied in London, it is found that these lamps give an efficiency of over 60 candles per cubic foot. The Author has, however, observed still higher efficiencies with high-pressure lamps of the "Graetzin" type when working at 2 lbs. per square inch. The increased efficiency of high-pressure burners is due to the fact that a greater proportion of the air necessary for combustion can be injected with the gas; there is consequently less cooling effect on the flame. Moreover, complete combustion can be obtained with a smaller flame, which is another way of saying that a higher temperature is developed. The highest flame temperature would be developed if the whole of the air necessary for combustion could be injected with the gas; but this is, of course, unattainable in practice. A small increase in the temperature of the flame produces a comparatively large increase in the amount of light developed. From the foregoing it will be seen that the inverted burner lends itself much better to a high gas pressure than the upright burner, and pre-heating may be carried to a higher degree, and in all probability much higher efficiencies will yet be attained in this direction. The essential conditions in high-pressure gas lighting, however, are that the pressure and quality of the gas shall remain absolutely constant. Failure to observe these conditions has, in some instances, caused dissatisfaction with the system.

Testing.

The most notable feature in connection with the large number of comparative tests of gas and electrical units, which are published from time to time, is the singular discrepancy in the observed results. Only recently a series of tests was published, showing results which turned out to be little more than half of those obtained by the officials of the municipal authority, which were subsequently published. It seems,

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therefore, that unless the methods of testing are clearly stated the results can possess very little value. It is not reasonable to expect such accurate results in the street as in the photometer-room, where all extraneous light can be excluded. Indeed, a street photometer can only be used with satisfaction where a whole street is illuminated with similar units, and even then the results are generally affected for purposes of comparison by the varying reflecting power of the roadway or adjacent buildings. The longer the range at which the observation is taken, the greater is the error from this source. The results shown in Fig. 3 were to some extent affected in this manner; but Nos. 2, 5, 6, 8, 9, and 10 on that Fig. were taken in an open space, with no other lights visible, and should therefore possess a greater degree of accuracy. For practical purposes the Author prefers a set of observations taken in the photometer-room at the critical angles, polar curves of tests taken in this manner are shown on Figs. 4 and 5.

It may here be explained that the tests of inverted burners were taken without a globe, in order to eliminate any error due to reflection, but a globe is essential to an inverted burner to develop its true efficiency. For testing electric lamps, a clockwork rotating arrangement was used with metallic contacts of ample area bearing on brass rings mounted on a suitably insulated spindle. The ten-candle Harcourt standard pentane lamp and the Simmance & Abady flicker photometer were used. For the tests of street lamps, a photometer was used which was kindly lent to the Author by Messrs. Alexander, Wright & Co., Ltd., of Westminster. This consisted of a metallic filament electric lamp worked from a battery in circuit with which a suitable rheostat and finely calibrated ammeter were placed. A flicker photometer fitted with an angle finder was again used. The observations were made by varying the resistance and consequently the light emitted by the electric lamp; the reading of the ammeter was then carefully noted as well as the angle and distance from lamp. Before starting and also at the conclusion of the tests the electric lamp was tested in the photometer-room through the whole range of the ammeter. The observations were taken at right angles to the direction of the light ray from the lamp and at a height of 4 feet from the ground. This plan was adopted in order that the curves shown in Fig. 3 might be more intelligible. It is well known that a

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flame arc lamp, unless fitted with a suitable reflector or dioptric globe, emits its maximum light at angles unsuitable for street lighting. It has therefore become customary to quote the illuminating value of these lamps in Mean Spherical Candle Powers. The term, however, conveys no meaning as to the value of the lamp *per se* for street lighting, and its use must be condemned if for no other reason than its clumsiness and the time required for ascertaining it. It is surely a poor street lamp that does not illuminate the ground in its immediate vicinity.

Methods of Charging for Public Lighting.

The usual method of charging is to assume a certain consumption of gas or current and to price out at so many lighting hours per annum. This method is satisfactory where the local authority supplies both gas and electricity. When this is not the case, however, difficulties may arise, and it would seem that some other method should be employed. A contract for the gas lighting of Calcutta was recently arranged in which the size of the gas nipples and the composition of the gas were specified. The Author has found that the gas in passing through the nipple exercises a cutting effect on the metal. Any increased consumption due to this cause would be at the cost of the gas supplier, and would rank as unaccounted-for gas. On the other hand, adjustable nipples are too easily tampered with, and generally give a lower efficiency than a properly drilled one-hole nipple. It may here be noted that when an admixture of water gas is used, the specific gravity being higher, a nipple with a hole of a given size will pass less gas than if coal gas only were used, and in determining the size of the nipple, due attention must be given to this point, as well as to the pressure of the gas during lighting hours in the district in which the burners are to be used; a governor on each lamp is an invaluable adjunct. Higher efficiencies are generally obtainable with a reasonable admixture of water gas, the flame temperature being somewhat higher than that of coal gas. Still another method of charging for public lighting is that of adopting a fixed price for a definite illuminating power, a system which has recently come into vogue in London, being particularly convenient where high power units are concerned. This method, however, involves the

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frequent use of a street photometer. The portable photometers which are principally used in this country are the Harrison, the Weber Portable Photometer, the Trotter Universal Photometer, and the Simmance & Abady. The latter has been adopted by the Westminster City Council; it is an ingenious instrument and possesses many advantages, not the least being that it is a direct reading photometer, and does not involve the interposition of an empirical standard. The principle of this photometer is briefly, an arrangement by which the amount of light falling upon one side of the photometer disc can be so varied by means of the simple turning of a graduated drum that it can be made exactly equal to the light falling upon the other side of the disc from the street lamp under test. The graduations of the drum can be read off in 100ths of candles or 20ths of candles according to whether the lamp to be tested is of very high power or of ordinary intensity.

The method of producing the variations of power of the standard light is by the opening and closing of a shutter, which allows more or less of a light of invariable intensity to pass through and impinge upon the disc. It may be best understood by reference to an ordinary photographic camera. In this the rays from an illumined object are projected upon a ground-glass screen, their images being seen inverted. The shutting or opening of a diaphragm such as the Iris does not vary the size of the picture, but only the amount of light, which is in proportion to the size of the orifice. In the street photometer the illuminated object is the interior of the whitened sphere, which is brilliantly illuminated by two electric lamps. The picture of the interior of this sphere is projected, much reduced, upon the white disc of the photometer, always of one size, but varied in luminosity, by the opening or closing of the shutter. The turning of the graduated drum affects the opening in perfect proportion. The accurate determination of the angle at which the test is made, independently of any inclination in the surface of the road, has an important bearing on the accuracy of the tests. This photometer is fitted with an instrument consisting of a combined level and quadrant, weighted so as to assume a truly vertical position whereby the angle can be determined with great precision, the reduced image of the lamp being projected through a lens on to the photometric centre.

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Authority for Controlling Public Lighting.

There will doubtless be a considerable diversity of opinion amongst the members of this Institution as to which department of a local authority should be entrusted with the control of the public lighting. From the foregoing it will be observed and generally conceded that modern exigencies demand the possession of considerable technical knowledge, and if full advantage is to be taken of improvements in the utilisation of gas and electricity, the co-operation of the chief officers of both departments should be secured, while the arrangement and disposition of the lamps should be in the hands of a local surveyor or engineer. Only by such co-operation between officials can the interests of the public best be served. It is much to be regretted that in many towns the interests of one department have been deliberately permitted to suffer to the advantage of the other. Personal predilections are indefensible where the public welfare is concerned.

Maintenance.

In discussing the subject of public lighting by gas, the first question that will probably be asked is, "What mantles do you use?" The Author's reply to such a question would be that mantles vary very much in quality from time to time, and that in consequence a great variety of mantles are used. For several years in West Bromwich it has been customary as far as possible to purchase mantles in the stocking form, impregnated with a standard solution and not collodionised. The mantles are burnt off and seasoned with high-pressure gas, and carried out in metal boxes fitted with suitable supports. In this way a mantle of the highest quality and strength is obtained. As regards ordinary collodionised mantles, a good quality will be found to be cheapest in the long run. In the choice of a mantle, due consideration must be given to the question of texture, whereas a mantle of open mesh is suitable for a "lazy" flame, one of closer texture should be used for a strong, active, and well aerated flame. The Woodall-Moon mantle testing machine will be found to be a most useful apparatus for detecting any falling off in the quality of the mantles supplied.

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Maintenance of Public Lamps in West Bromwich.

Type of Lamp.	Average No. of Mantles used per Burner per Annum.
Old pattern with "C" burner	8·3
14 inch lamp with angle burner	6·8
16 „ „ „ double inverted burners	7·6
14 „ „ new pattern lamp with single inverted burner ..	4·0

The Author regrets that he has no authentic particulars of the life of electric lamps of the newest form. This must depend in a large measure upon the regularity of the voltage, which shows considerably more variation in the case of the circuits at the gas works than would be found in the town supply, though kept perfectly constant during the testing of the lamps for illuminating power.

Automatic Lighting.

A paper on street lighting would in these days be incomplete without some reference to this subject. The average number of lamps lighted and extinguished by a lamplighter appears to be about 100, and the time occupied in each operation about 1½ hours; so that by the use of automatic lighters the lighting time may be reduced by nearly two hours per day. Automatic lighters, of which there are almost numberless forms, may be divided into two classes. (1) Those operated by clockwork, and (2) those operated by a momentary increase in the pressure of gas in the mains. The latter way may be subdivided into two classes, one in which the gas valve is operated by a bell floating on mercury or other liquid, and the other in which the gas acts on a diaphragm contained in the instrument which opens and closes the gas-way. The latter form of apparatus is probably the more reliable, but before deciding upon an installation, a careful study must be made of the gas pressure in the mains in all parts of the district, or failure will result. If the mains in any part of the town are overworked during lighting hours, there is considerable difficulty in timing the pressure wave so that it may not be excessive and cause the blowing of meters, but shall be sufficient to reach the remote parts of the district, and not be absorbed by the rapid increase which is taking place in the consumption of gas *en route*. Installations of both systems have been used in West Bromwich,

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but it is found that the atmospheric conditions have a deleterious effect on the mechanism of the clockwork, and until the distributing system is reorganised, the conditions will be unfavourable to the use of the latter type unless adopted throughout the town.

The chief cause of failure of automatic lighters is found to be in the bye-pass. It is probable that in the near future pyrophoric ignition will be successfully applied to public lamps. The use of Hertzian waves is also not beyond the bounds of possibility. For the lighting of the lamps in West Bromwich, excepting the comparatively few which are automatically controlled, an acetylene torch is used.

Conclusion.

The Author has found much difficulty in dealing with the many aspects of interest presented by the subject under consideration within the limited compass of a paper, and it has only been possible to refer very briefly to many of them, but in conclusion he would again express the conviction that for the satisfactory lighting of our thoroughfares, units of comparatively small power should be employed, and that they should be so spaced that contrasts in the intensity of the light falling on the road surface are reduced to a minimum. The Councils of the Institution of Electrical Engineers and the Illuminating Engineering Society have recently appointed committees for the consideration of the subject of street lighting, and have invited the co-operation of your Council and that of the Institution of Gas Engineers, and it is to be hoped that as the result of their deliberations a satisfactory specification will be evolved which will be generally applicable.

The Author desires to acknowledge the valuable assistance rendered by his colleagues of the electrical department in granting him the loan of lamps and apparatus, and by Mr. D. G. Moore, the chemist at the gas works, in conducting the tests of the various burners and lamps.

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DISCUSSION.

MR. J. T. EAYRS: I think it might be useful if Mr. Copp in the course of his reply would tell the members where they will find the different systems of lighting in operation in the town—the high-pressure gas, the inverted burners, and the different systems of electric lighting.

MR. H. GILBERT WHYATT: The first remark I disagree with is, "In modernising the lighting of a district, and having decided on the power of the lamps to be installed, the better plan is to re-arrange the spacing of the lamp-posts." We quite admit, or, personally, I quite admit, the correctness of this view in country roads, or in the residential roads of a town not much cut up by cross-streets. But in the centre of a town where there are a large number of cross-streets and you have a lamp at every street corner it is very different, for if you rearrange your lamps you have to double the number. Eighty-three yards may be assumed as a suitable distance at which the lamps should be placed apart, but if you put in intermediate lamps making the space between each 41½ yards, you make the rest of the town jealous. So I suggest it is a far better solution of the problem to put a double burner in the lantern, and then the people in the other districts of the town are not made jealous. It is quite certain if you set down lamps 40 yards apart there is a cry for a similar condition of affairs in other streets, and your lighting bill may soon be doubled. The second point is as to centre lighting. Mr. Copp says that centre lighting is generally regarded as preferable to side lighting. I am not prepared to admit that. The vehicles which go along the roads carry their own lights. The light we want in our streets is for the convenience of foot passengers, and, where streets cross, to enable them to pass from one side to the other without coming into contact with vehicles. My own opinion is that side lighting is the correct thing. As to the methods of charging for public lighting, we have lately, in Grimsby, revised our lighting specification. We had, until recently, a specification that the burners should be a certain size and burn a certain number of cubic feet of gas per hour. But our electrical engineer has been desirous of lighting the streets by electricity, so we have changed over to what Mr. Copp puts in the third place, a definite illuminating power, and we are

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specifying that at a certain distance from the lamp there shall be a certain candle-power obtained. Our electrical engineer is prepared to light certain streets for exactly the same price as the gas company has charged, viz. 3800 hours for 3*l.* 12*s.* 10*d.* per lamp—it being specified that there must be a candle-power of 50 at a distance of 1 foot from the lamps. We have a photometric examination, and if the gas company is not giving the light there is a fine. The electrical engineer is quite prepared to pay the same fine. In regard to the measurement of the light, Mr. Copp says: "A street photometer can only be used with precision where a whole street is illuminated with similar units, and even then the results are generally vitiated by the varying reflecting power of the roadway or adjacent buildings." But it gives an indication of what the light is. If the specification is 50 candle-power and you find 47 candle-power on the photometer you would say nothing about it, but if there is only 27 candle-power then you make your complaint. If there is an allegation that the street lighting is not up to the specification, you cannot take a lamp down to the room and measure it there; you must do it in the street. For theoretical purposes the tests may be made in the photometer room, but for practical purposes it must be taken in the street to see whether you are getting what you pay for. I do criticise Plate 6, the lighting time in West Bromwich. I notice in summer time he lights his lamps a full hour before sunset, which is an absolute waste of money. For instance, last night a quarter past ten—one and a quarter hours after sunset—would have been early enough. The West Bromwich people could save money if they postponed the lighting to an hour after sunset in the summer months in place of an hour before sunset. They would save at least two hours' lighting.

MR. COPP: The lighting and extinguishing takes over an hour.

MR. WHYATT: I still have to criticise the time of lighting. If this is the time for beginning to light you are too late in winter; you ought to have the lighting finished before sunset. I am quite prepared to admit this, your atmosphere is very much less clear than ours and in November or December you ought, probably, to finish lighting by three o'clock.

MR. T. CAINK: The paper shows the disadvantage which gas lighting has against electric lighting in the lighting and extinguishing of street lamps. I think least, myself, of the

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portion of Mr. Copp's paper relating to automatic lighting. It is at any rate apparently not up to date for the lamplighter to go round and light and extinguish each separate street lamp as is done in the case of ordinary gas lighting, while electric lights can be put on and shut off at a moment's notice. The problem of automatic street lighting is one which I endeavoured to solve by temporarily raising the pressure in the gas mains. That method has obvious advantages over that of clockwork systems, inasmuch as advantage can be taken of economising on light evenings. On the other hand, if there should be a dark evening you can light half an hour earlier; thus the lighting can be adapted at the particular moment which the manager at the gas works thinks is desirable. That means the saving of a large amount of gas on exceptionally light evenings, and on the other hand the public are not inconvenienced by the lamps being lighted too late on dark evenings. The difficulties we are confronted with are those mentioned in Mr. Copp's paper—the variations of pressure in the mains due to the varying consumption which renders it uncertain whether the whole of the lamps will be lighted by the increase of pressure, and if they are extinguished by reduction in the pressure, which is usually the case, then an unexpectedly heavy draft upon the mains may reduce the pressure so that the lamps become extinguished before the time for extinguishing has arrived. In order to meet that difficulty it occurred to me that it was necessary to adopt a different form of station governor from that usually manufactured. The ordinary station-governor is designed for the purpose of maintaining a uniform pressure on the mains from the works—a pressure such as the engineer considers sufficient to meet the demands of the moment; a governor of that kind seems to render it altogether uncertain what will be the minimum pressure maintained in the remote part of the mains. With the object of overcoming that difficulty it seems necessary to devise a governor which will change the pressure automatically to suit the demands on the mains from time to time. Such a governor was designed and found to answer its purpose perfectly well. I should like to know whether Mr. Copp has had experience of such a governor, for it seems to me that the question of automatic lighting depends upon the use of an appliance which will automatically change the pressure to suit the consumption and thus render the pressure approximately uniform

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throughout the system of mains in use. The other point is the difficulty of maintaining the by-passes intact. They are apt to choke up, so that when the pressure is put on there is no light. That difficulty could be overcome by using electric ignition, which could be easily applied by having small batteries fitted in connection with each lamp-post and making a temporary contact when the pressure is put on for lighting. I think by adopting this method the question of automatic lighting can be met successfully, and in that respect gas lighting would not stand at the same disadvantage as it does now for public lighting.

MR. H. RICHARDSON: I would like to ask Mr. Copp if he has used the tramway poles for street lighting purposes. We are getting such a forest of posts in the streets that it is well to try and reduce the number. If Mr. Copp has tried fixing incandescent gas lamps on the poles I should like to ask whether he has found the life of the mantles satisfactory.

MR. SHOLTO DOUGLAS: I would like to ask Mr. Copp whether the street lamp he has on exhibition before us is on the market, and, if so, who is the maker, and the price. With respect to governors, I would like Mr. Copp's opinion on the cheaper forms of governors, at, say, 1*s.* 6*d.* and 2*s.* each, for use in connection with vertical incandescent burners.

MR. W. JONES: I would like to know whether advantage is taken by local authorities generally to dispense with lighting on the fine nights when the moon is full, for it seems to be the practice in my own neighbourhood to economise in that fashion.

MR. J. BIRCH: Could the Author give information as to the efficiency as regards lighting and maintenance of the inverted burner, either singly or in duplicate in the lantern?

MR. F. OSCAR KIRBY: There are one or two points on which I would like to ask for further information. In the first place, I would like a further explanation of the statement that the standard to be adopted in any town or locality should bear some relationship to its rateable value per head of population. I would like to know whether this refers to districts of a town or simply the population as a whole. It seems to me that such a standard would not be generally applicable. Is it intended to convey the idea of a standard rising *pro rata* with the rateable value of the locality lighted? If so, one may instance the case of a side street with highly assessed factories or warehouses on both sides and practically no population or pedestrian traffic

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during lighting hours. Further on in the paper three essential conditions for satisfactory street lighting are quoted. I will suggest a fourth, which may be termed depth of illumination. For satisfactory, equable, and uniform illumination there must be sufficient light for high vehicles, as, for instance, motor omnibuses, though of course it may be said that all vehicles should furnish their own means of illumination. Mr. Copp mentions that large units of light placed fairly high may shine through the first-floor windows. That would not appear to be a serious objection, as in thoroughfares such as Victoria Street, Westminster, where large units are necessary, the first-floor rooms are not generally in use during lighting hours, being mostly offices or storerooms. Mr. Copp's figures as to the relative candle-power, height, and spacing of lamps do not appear exactly to confirm the axiom in his paper, and with which I entirely concur, that, the greater the candle-power of the lamp, the higher it should be placed, and can I take it that the figures adduced are the results of actual tests? They do not, at any rate, appear to be in accord with the law of inverse squares.

We are indebted to Mr. Copp for drawing our attention to the doubtful utility for general use of the term "mean spherical candle-power" as a standard for illumination. That standard has recently been adopted in connection with the Westminster Lighting contract, and may be the most satisfactory one for the conditions obtaining in that case. There is, perhaps, a tendency to look upon it as a guide and precedent for any and every case. It is therefore important to bear in mind that the practical value of a lighting source should be computed on a basis which has reference to the conditions of usage.

Mr. H. A. Garrett: As to the methods of charging for public lighting, I see no reference in the paper to the method adopted in many towns known as the average meter system. I notice that it is stated in the paper that it is usual to assume a certain consumption of gas or electric current, but that is capable of being widely dealt with, and the question is whether it is not better to adopt the average meter system, that is to say, one meter to every eight or ten lamps and pay for the actual consumption. I do not know whether Mr. Copp has had any experience of that method of paying for gas for street lighting. I am speaking of gas obtained from a private company and not from a gas-works belonging to a corporation.

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THE PRESIDENT: Before calling upon Mr. Copp to reply to the various questions raised in the discussion I would ask you to pass a very hearty vote of thanks to him for the paper he has given us this morning. I should like to say the placing of lamps in the borough, and the hours of lighting—everything beyond the supply of gas—is done by the Highways Committee. The Lighting Committee only do it by contract as if it were a private firm. The number of hours of street lighting, both by gas and electricity, belongs to my department. In arranging these matters it is needless to say that Mr. Copp, the electrical engineer and myself work in that amicable way which, I think, all officials of any Corporation should do.

The vote of thanks having been unanimously passed,

MR. H. E. COPP, in reply, said: I am indeed grateful for the kind reception you have given to my paper. I would like to say how much I appreciate the honour of being asked to contribute a paper on this subject. I also welcome the criticism it has elicited; that is, indeed, the purpose for which the paper was written. We all have our own opinions, and discussions of this kind often result in our modifying our views on different points.

I have some difficulty in answering Mr. Eayrs's question as to where the different lamps are to be seen, for they are dotted about promiscuously all over the town. We are improving, as far as possible, the more important thoroughfares first, both your President and myself recognise that there remains a great deal to be done in the direction of improving the public lighting of West Bromwich. Some high-pressure gas-lamps would be found in St. Michael's Street, and the newest form of inverted burners and lanterns in Beeches Road. In High Street you will see the electric arc lighting, which I ought to say, in fairness to the electricity department, is somewhat antiquated. There are to-day very much better lamps on the market than these. At eleven o'clock the arc lamps are switched off, and the metallic filament lamps switched on; it is a question whether the lighting is not better after that time than before, at any rate from the point of view of even illumination. In St. Michael's Street there is a high-pressure gas-lamp of 3000 candle-power. I should like to say that this lamp does not give quite 3000 candle-power according to my observation, but it must not be assumed from that that this type of lamp is not

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capable of doing so. As a matter of fact the same pattern of lamp is elsewhere giving 3200 candle-power, but I think they are working at a higher pressure than we are in West Bromwich, probably nearer 3 lbs. than 2 lbs. pressure per square inch. With reference to Mr. Whyatt's remarks as to his difficulty in spacing lamps, when he says that his lamps are as much as 83 yards apart, it is to be hoped that in Grimsby they go in for large units of light, or else the lighting must be very poor. The remedy there seems to be to put in higher lamp-posts and raise the unit of illumination. In my paper I say it is better to re-space the lamp-posts than to put two burners in a lantern. If you are going to make the lamp-posts higher there would be no objection to increasing the unit of light; in a great many cases that would be the cheapest way of solving the difficulty. With regard to centre-lighting I was careful to avoid saying I am in favour of it. From reading the technical publications and also noticing what has been done in Germany—where they are adopting centre-lighting in nearly every large town—and having in mind also the experiments which have been carried out in Canon Street, London, I think it is very likely that centre-lighting will take a very important place in the future. But, personally, I am not altogether in favour of the method, because, unless the units of light are very large and are fixed high above the road, a horse and cart proceeding along the road will throw a very deep shadow on the pavement. Very few places in England have tried this system up to the present, although it is under consideration in many places. With regard to Mr. Whyatt's remark as to the lighting of Grimsby, we people who read technical communications on the subject of public lighting and follow the subject closely are forced to the conclusion that Grimsby is more or less a law unto itself on the question of public lighting. I do not know what method of testing they have in use, but the arrangement would lead one to think that the question of tests ought to be a most important one for Grimsby. I have carefully refrained in my paper from giving the comparative costs of gas and electric light. I think it is quite unnecessary, as every one knows the efficiency that can be obtained from a town supply of gas, and must also know the consumption of electricity by the modern metallic filament lamp. It is simply a question of arithmetic. Some people prefer electric lighting for various reasons. One would not

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expect low-pressure gas lighting on Brighton front, for instance. But there are places suitable for both forms of illuminant, hence the importance of keeping one's mind free from prejudice and judging each case according to local conditions. With regard to Mr. Whyatt's criticism of our lighting and extinguishing chart in West Bromwich, this was compiled from the actual figures of last year. The climatic peculiarities of West Bromwich make the times of lighting and extinguishing appear inconsistent. I do not say it is a perfect chart, or an ideal one. We have 3940 hours per annum to light, and your President and myself in collaboration fix the most suitable time for both lighting and extinguishing. You notice the difference between spring and autumn, for instance. Mr. Caink referred to pressure lighting. The lighting of public lamps by pressure from the works is all right in a flat district where there is an equable pressure all over the town. I think I have made that point clear in my paper. The objection to pressure lighting is that if you have varying waves of pressure in different parts of the district you may have many failures. For that reason I prefer an automatic clockwork lighter and extinguisher. We have tried most forms of automatic lighters. The extinguishing is not done by taking off the pressure, it is invariably done by another wave of pressure. As regards the governor for proportioning the pressure to the consumption, this object is accomplished by Braddock's "counter-balance governor," which is fitted with a double valve. I have had considerable experience in working these governors, and the usual method of applying the pressure is by lowering a tank of water on to the top of the governor bell; there is a tap at the bottom of the tank which gradually discharges the water, so that when the tank is empty the pressure resumes its normal height. Mr. Caink, from his remarks, seems to assume that automatic lighting is more or less experimental at the present time. That is not so; it is an established fact, both as regards pressure and clockwork systems. I may say that there are whole districts lighted entirely by automatic methods. One of the most notable is Newcastle-on-Tyne, where several thousands of automatic lighters are in use. With regard to Mr. Richardson's question as to lamps on tramway poles, I have found that inverted lamps fixed in that way are perfectly satisfactory, and the renewals even less than with the ordinary lamp-post. We have

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quite a number in West Bromwich on tram poles. In reply to Mr. Douglas's question, I am afraid this lamp cannot be obtained at present; indeed, I should not like it to be possible for it to be obtained in its present form, as it will be generally admitted that it is not a thing of beauty; but it is the only one I could arrange to show you to-day; I have redesigned it in a much more presentable form. One of the main points of the lamp is that the reflectors can be kept clean, because the air is excluded. The method of cleaning it is by unscrewing the lock nut and swinging the top back, the burner comes right away from the mantle and leaves the glass behind. I know of no satisfactory governor for street lamps which can be purchased at the price of 1*s.* 6*d.* or 2*s.* The best lamp governor I know is probably the Bryan Donkin, but I do not remember the price; there are, however, several kinds on the market. In reply to Mr. Jones's question as to the omission of lighting while the moon is at the full, that is probably satisfactory for country districts, but it is totally inadmissible for urban districts. I should not like to contemplate the effects of leaving the town of West Bromwich unlighted during the period of full moon, because very often the period passes and we have not been able to observe that there has been one.

MR. JONES: That is the difficulty with us.

MR. COPP: You have a much clearer atmosphere at Colwyn Bay than we have. With regard to Mr. Kirby's remarks, when I say that the standard of lighting should bear some relationship to the rateable value, I simply mean that as a general statement. I certainly think it should bear some relationship to it. For instance, we will hardly light Edward Street, West Bromwich, on as generous a scale as Westminster would light its main thoroughfares. It should have some relationship to a general scale; I do not mean any particular road, but the general standard of lighting to be adopted in the town. I quite agree with Mr. Kirby that I should have suggested a definite standard of illumination as one of the essential conditions of satisfactory street lighting. Mr. Kirby criticised my figures relating to what I stated as an axiom that, "the greater the candle-power of the lamp, the higher it should be placed," I put those figures in to illustrate the truth of that axiom. If Mr. Kirby looks at it carefully, I think he will find that they bear out that statement. In reply to Mr. Garrett's observations as to the method of

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charging on the average meter system, there is not so much necessity nowadays for that, because everybody knows that with a particular size of burner and mantle, your limits of consumption are very narrow indeed. Of course, in the days of the flat-flame burner, it was absolutely essential. One gentleman who took part in the discussion referred to electric ignition. We have also tried that method in West Bromwich, and I really think it is a practical system; but some three or four months ago I decided to do away with the by-passes, some of which are very extravagant as regards consumption of gas, and light by means of an acetylene torch. We have a special torch, which is an extremely handy arrangement, and it possesses the advantage that it does not blow out in the worst weather. I have received no complaint of it up to the present from the lamplighters, that being a sure sign that it is quite satisfactory. I have a sample here for your inspection. There is just another matter I desire to emphasise; that is the question of testing. When I say that the observations were taken at right angles in the direction of the light ray from the lamps and at a height of 4 feet from the ground, I am perfectly aware that I shall be severely criticised by my electrical friends, but I am perfectly prepared to more fully state my reasons for coming to the conclusion to state the tests in that way. If I were to have charted the curves of illuminating values in the way some would wish us to arrive at them, namely that of plotting the candle-feet on a horizontal plane, Plate 3 would have been unintelligible. It is only necessary to multiply these figures by a constant to turn them into the figures of light falling on a horizontal plane. I prefer my method, because it is clearer on the chart.

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FIRE PROTECTION IN TOWNS.

By REGINALD BROWN, Assoc.M.Inst.C.E., *Member*, Surveyor and Engineer to the Urban District Council, Southall-Norwood.

It is curious to note that although many of the Author's colleagues are chief officers of the fire brigades in their respective districts, and their advice, as surveyors, is sought when it is desired to instal "up-to-date" fire appliances, no paper on the subject has hitherto been submitted to the Institution. Probably this is due to the fact that, at present, there are few firms who lay themselves open to carry out work of this sort, and that it is thought best to place the whole matter, including the design, in the hands of a selected firm; but this reasoning may be applied to other branches of our profession, and still we think it advisable to be *au fait* with the matters so that we may know when the work is done properly. It is for this reason, and also that the paper may be used as one of reference, that the Author has attempted to collate information on the subject, and to submit it to his colleagues with the hope that it may be found useful to them.

The necessity of providing all districts with fire appliances is surely not denied; the day has gone when a man can be found to make the remark "let the fire have a chance"; although one does sometimes hear the remark that, if it were not for the fire brigade more work would be found for the builder. This may be perfectly true—so far as the building is concerned—but local authorities have also to look after the protection and saving of life in addition to property. When a fire has got well hold there is no telling where it will end. As Shakespeare truly said, "A little fire is quickly trodden out, which being suffered, rivers cannot quench." For many years past the Legislature has given powers to urban authorities for the formation of fire brigades and the purchasing of all necessary appliances.

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The Police Clauses Act, 1847 (incorporated with the Public Health Act, 1875) gives power to an urban authority to purchase or provide such engines for extinguishing fires and such water buckets, pipes, and other appurtenances for such engines and such fire escapes and other implements for safety or use in case of fire and may purchase, keep, or hire such horses for drawing such engines as they think fit, and may build or hire places for keeping such engines with their appurtenances, and may employ a proper number of persons to act as firemen, and may make such rules for their regulation as they think proper, and give such firemen and other persons such salaries and such rewards for their exertions in case of fire as they think fit. The Public Health Act, 1875, also provides that every urban authority shall cause fire plugs and all necessary works, machinery, and assistance for securing an efficient supply of water in case of fire to be provided and maintained, and for that purpose may enter into an agreement with any water company or persons; and they shall paint or mark on the buildings and walls within the streets, words or marks near to such fire plugs to denote the situation thereof, and do such other things for the purposes aforesaid as they may deem expedient.

The Waterworks Clauses Act, 1847, further provides that a company is bound, at the request of the authority, to fix fire plugs in their mains at not more than 100 yards from each other or in positions indicated by the local authority. The company is further to maintain the fire plugs in proper order, but the expense of providing, fixing, and maintaining such fire plugs must be borne by the local authority. The fire plugs so fixed must be kept charged with water, under the pressure specified in the Act of the Water Company, unless prevented by frost, drought, or unavoidable causes or during repairs, and it may here be noted that the water may be taken therefrom free of cost for actual fire purposes, but not for practice.

The question of fire protection therefore resolves itself into three heads:—

(1) An ample supply of water easy of access.

(2) The provision of a fire brigade and the necessary appliances.

(3) Means for quickly notifying the brigade of the existence of a fire.

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1. Water Supply.

In some towns the water is supplied to the mains at such a pressure as to permit of the water reaching considerably higher than the highest building, and all that is necessary is to attach the hose to the nearest standpipe and turn on the water, but in the majority of towns the water has to be forced through the hose by means of a fire engine.

In both cases—especially the latter—it is necessary to test the mains so as to make quite sure that an efficient supply of water is always at hand. To ensure an ample supply of water implies control of the sizes of the mains, etc., but as these, in many instances, are owned by companies the Author does not purpose entering into the question of the proper size, except to state that no main should be less than 4 inches internal diameter.

Fire Hydrants.—The district should be mapped out and these appliances fixed in convenient positions so as to control the whole of the "built upon" area. Many good forms of hydrants are on the market, and it would serve no useful purpose to describe them. They are arranged in pits below the footway, and water is drawn from them through a portable standpipe coupled to the outlet, the upper end of the standpipe being bent over to deliver in a horizontal direction. The provision of an adaptable "meter" or "gauge" is essential for ascertaining the capability of individual fire hydrants to satisfy the requirements of fire engines for water. Such a "rate of flow" gauge is that invented by "Prentice" and described in Vol. 143, p. 281, of the Proceedings of the Institution of Civil Engineers. It is very convenient to use, and its portability and simplicity of construction renders it a valuable instrument, as the results can be relied upon to give within 5 per cent. of the real discharge. The gauge is based on the principle of ascertaining the flow of water by means of a "pitot" tube. Briefly the instrument consists of a short length of pipe (12 inches) screwed to the outlet of the hydrant and of the same diameter ($2\frac{5}{16}$ inches). Near the gauge outlet there is inserted a "pitot" tube, placed, with its opening facing the issuing stream, midway between the centre and the side of the tube. Depending from this tube is a looped pipe supporting a Bourdon gauge, the gauge having the discharge in gallons per minute and the head

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in feet due to velocity marked on the face of the dial, so that the result can be read without calculation. The instrument is made by Messrs. G. Kent & Son, of Holborn, and can be hired as well as purchased. A few years since the Author had occasion to test the fire hydrants in his district with this instrument, and the information obtained from such tests showed very clearly indeed the location of the poorly supplied hydrant, and he was able to emphasise this fact when urging for improvements in the water supply. The facts ascertained by the tests were not questioned by the water company, so that it may be taken they were quite satisfied as to their accuracy. The table below shows the gaugings of the hydrants referred to:—

No.	Bore of main.	Delivery in gallons per minute with free discharge into the air.	No.	Bore of main.	Delivery in gallons per minute with free discharge into the air.
	Inches.			Inches.	
1	4	150*	19	9	340
2	4	115*	20	4	65*
3	4	55*	21	4	58*
4	4	45*	22	4	55*
5	5	205*	23	4	48*
6	5	215*	24	4	120*
7	5	225*	25	4	125*
8	5	240*	26	4	130*
9	4	185*	27	4	130*
10	9	320	28	4	140*
11	9	260*	29	4	135*
12	9	350	30	4	130*
13	5	220*	31	4	120*
14	9	360	32	4	120*
15	9	370	33	4	130*
16	9	340	34	4	170*
17	9	340	35	4	115*
18	9	360	36	4	64*

NOTE.—As the fire engine in use required a supply of 300 gallons per minute to keep it going at full power, the table shows at a glance the necessity of improving the supply at those hydrants marked with an asterisk, or taking additional supplies from other sources (if they are convenient). Such information is of the greatest value to the chief officer of the fire brigade, as he will know what supply to expect when proceeding to any part of the district.

Marking Positions of Hydrants.—The duty of indicating the position of the fire hydrants rests upon the urban authority. It is usual to mark their positions by fixing cast-iron tablets at

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the back of the path, opposite the hydrant, with the distance indicated thereon in feet and inches. It is essential to ascertain by periodical inspection that these plates are not altered in position or removed, as the absence or alteration in position might, in the case of a serious fire, hamper the services of the brigade by causing a loss of time in searching for the hydrant, and might also lead to heavy damages being claimed from the authority by the owner of the property. Whilst on the question of a water supply for fire extinguishing purposes, the Author cannot refrain from emphasising that it is the duty of the authority—in the words of the Acts previously referred to—to see that an efficient supply of water is provided and maintained, and for that purpose may enter into an agreement with the water company. This, in the Author's opinion, seems to imply that, failing agreement with the water company for an efficient supply, the local authority has no alternative but to provide the supply themselves, and, in that case, the supply can only be for fire-extinguishing purposes, and not for domestic supply. The Author has in mind many cases where this, if this opinion is correct and if acted upon, would involve the ratepayers in a very considerable expenditure.

2. Fire Brigade and Appliances.

Brigades.—These may be divided into (1) paid, (2) voluntary, and (3) a combination of the two. In large towns the brigade is usually a paid one, the members residing at the central or sub-stations; whilst in a small district the brigade is either kept up by voluntary subscriptions and the appliances are provided by the local authority, the men giving their services. Between these two extremes there may be several modifications. One or more men may be in constant attendance at the central station—and are consequently paid—or the men may be paid a nominal retaining fee and also for all time lost from their ordinary employment only, their services at fires during the evening or night being voluntary. The method adopted will be governed by the expense to which the district can go. The number of firemen will also depend upon the extent of the district and the appliances provided, but it is as well not to overstaff the brigade. The Author does not

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here wish to convey that a brigade should be under-staffed, but sufficient men should be appointed to deal with all the appliances provided, bearing in mind that a chief officer has power to pay for outside help should he require it. The rules of conduct of the brigade will vary in each town, but the Author gives below (for reference) suggested rules for a brigade, the men being paid a nominal retaining fee.

Rules.

1.—The brigade is organised by the hereinafter called the Council, in pursuance of the powers vested in them for the protection of the lives and property of the inhabitants of the Urban Sanitary District from loss and damage by fire.

Members.

2.—The brigade shall consist of the following:—A chief officer, secretary, engineer, second engineer, two escape conductors, driver, and eight firemen; and every member of the brigade shall within two days of his appointment sign the memorandum contained in the memorandum book kept by the secretary—and shall be furnished with a copy of these rules.

3.—The management and general supervision of the brigade is vested in the Works Committee of the Council, and the command and control is vested in the chief officer for the time being.

Duties—Chief Officer.

4.—The chief officer shall be responsible for the control and general conduct of the brigade and for the proper and efficient performance of the duties by every member thereof, and shall take care that the rules of the Council relating to the brigade are strictly observed. He shall inspect all the plant, uniform, and equipment belonging to the Council at least once in every three months, and shall report monthly, or more often if necessary, to the Council on the work of the brigade.

He shall order a sufficient number of drills for the purpose of thoroughly instructing the firemen as to the use of all the appliances of the brigade, and cause all notices to be posted on the station notice board or otherwise.

The chief officer shall within 48 hours after a turn out of the brigade to a "call" furnish to the clerk to the Council a full report thereof, together with an account of the expenses incurred thereat.

Engineer-in-Charge.

5.—The engineer-in-charge shall assist the chief officer in the discharge of his duties, and shall take charge of the brigade in the absence of the chief officer, in which case all his duties will be similar to those of the chief officer.

He will be held responsible for the steam fire engine being kept in perfect working order, and ready at all times for immediate service, and shall report any mishap or other accident that may render the engine unfit for service to the chief officer.

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He shall be responsible for the fire engine, engine house, fire brigade premises, with all plant and appliances of every description being kept clean and in good order, and periodically examine same, and immediately report to the chief officer any plant or appliance that may be unfit for service. The engineer-in-charge shall take entire charge of the steam fire engine, and shall, directed by the chief officer, drive the same at all drills, and fires.

He shall also instruct such members of the brigade as may be appointed by the chief officer for that purpose in the management of such engine in order to qualify them to take charge of the same.

The engineer shall keep a stock book in which he shall enter all plant and appliances belonging to the brigade, and shall keep an account of all stores necessary for carrying on the work of the brigade, and shall be held responsible by the chief officer for the serving out of same for the use of the brigade.

Assistant Engineer.

6.—The assistant engineer will be subject to the directions of the engineer-in-charge, and shall make himself thoroughly efficient in all the duties laid down in these rules for the engineer-in-charge, and shall assist in all work appertaining to him, and generally as he may from time to time require under the direction of the chief officer.

Secretary.

7.—The secretary shall keep the following books, which shall be provided by the Council:—

(*a*) A roll book in which he shall enter the names and addresses of the members in order of seniority, to be determined according to the date of joining the brigade.

(*b*) A drill register, in which he shall enter the names of all members present at each drill.

(*c*) A report book, in which he shall enter all the reports of fires in and out of the district.

(*d*) A minute and finance book for the use of the brigade.

(*e*) The memorandum book.

The secretary shall, under the instruction of the chief officer, write all notices for drills, etc., and be responsible for notifying all members of the brigade of same.

Escape Conductor.

8.—The escape conductor shall, if he is so directed by the chief officer, or if in the absence of such order he deems it necessary, take the escape to a fire, and shall remain in charge of it so long as he deems it necessary for the saving of life. As soon as there is no further need for the use of the escape the escape conductor shall place the escape in a safe position and report himself to the chief officer or officer-in-charge and place himself under his orders. In the absence of the chief officer or officer-in-charge, the escape conductor first at the fire shall take the command.

Firemen.

9.—In the event of the chief officer, engineer, second engineer, and escape conductor not being present at a fire or drill, the senior member, for the time being, shall take the command, and the members present must render the same

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obedience to him whilst in command as they would to the chief officer, and he shall be vested for the time being with all the power of the chief officer, to whom he shall report.

10.—On an alarm of "fire" being given, every member shall proceed with reasonable dispatch to the fire station unless he knows of, and is near to the scene of fire, in which case he may proceed at once to the fire. Any member who wilfully neglects or refuses to attend with reasonable dispatch at a fire after being summoned, shall be liable to a fine of 2*s.* 6*d.* for the first offence, unless he can produce a reasonable excuse. For a second offence he shall be liable to instant dismissal from the brigade.

11.—All members of the brigade shall be furnished with uniform and equipment by the Council. Such uniform and equipment to remain the property of the Council, and must be returned to the fire station in good condition (fair wear and tear excepted) four days previous to a member leaving the brigade. Each fireman shall keep his kit and equipment in a thoroughly clean and serviceable condition and the bright metal well polished. The uniform or boots shall not be worn except when the fireman is engaged in fire brigade duties or on parade.

12.—The Council shall insure all members of the brigade against injury or death while on duty on the terms set out in the policy of the company with which the insurance is effected, and every member of the brigade shall accept all sums paid by the company assuring against accidents in respect of any injury, in full satisfaction of all claims against the Council.

13.—The brigade shall attend all fires in the Council's district, and may attend fires without the district upon receiving a call by the police or by an officer-in-charge of the brigade belonging to the district where the fire is raging.

In all cases of calls to fires outside the district the chief officer, or in his absence from duty, the officer-in-charge is to use his discretion as to whether the brigade shall attend or not.

14.—Every officer and member of the brigade when on duty is strictly forbidden to accept any beer, wine, spirits, or other intoxicating liquors from any persons. The chief officer or officer-in-charge may in his discretion in the case of a long, arduous attendance at a fire or drill, or in cold and severe weather (but not otherwise) provide the officers and members of the brigade attending such fire or drill with refreshment of a plain but substantial character at a cost not exceeding two shillings in the case of a fire, and not exceeding sixpence in the case of a drill, for each officer and member of the brigade present thereat.

15.—All applications for appointment to the brigade shall be made through the chief officer. All cases of suspension shall be reported to the Works Committee, with whom shall rest the power of dismissal.

The said Committee shall also have the power to dismiss instantly from the brigade any member whose conduct is, in the opinion of the chief officer, injurious to the discipline or the interests of the brigade.

No member of the brigade shall write to the Council or Works Committee or communicate with them, or either of them, or any member thereof, either directly or indirectly except through the chief officer, but any written complaint or communication made to the chief officer shall be submitted to the Works Committee at the first meeting of such Committee held after the receipt of such complaint or communication.

16.—All members while on duty, drills or fires, shall obey the orders of the chief officer or officer-in-charge and shall not take orders from any other person. Any member who breaks these rules or who disobeys the lawful orders of the chief officer or officer-in-charge shall be liable to suspension.

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RETAINING FEES.

17.—The following retaining fees will be paid by the Council :—

	£	s.	d.	
First engineer	7	10	0	per annum
Second engineer	5	0	0	„ „
Secretary	4	0	0	„ „
2 Escape conductors	4	0	0	each „
8 Firemen	3	0	0	„ „
Driver	3	0	0	„
Call boy	1	0	0	„

18.—Each fireman will be responsible for that part of the general cleaning, and other duties at the fire station, as shall be allotted to him by the chief officer or engineer-in-charge.

ALTERATION OF RULES.

19.—The Council shall be empowered to make such alterations to these rules as may from time to time be considered expedient.

Notice of such alterations or of intended new rules, shall be posted on the notice board at the fire station fourteen days before they take effect.

Appliances.—The Author does not think it necessary to touch upon all the appliances in use by a fire brigade, such as fire escapes, scaling ladders, hose, hose trucks, and other accessories, nor upon the various appliances in use for automatically opening the doors of the fire station, stable doors, swinging-harness, and such-like appliances, as full particulars of these can be found in any catalogue of firms making same, but it may be of interest to discuss the types of fire engines—the most important appliance in connection with the subject-matter of this paper. Fire engines may be of various kinds, such as manuals, chemical engines, and steam or certain other motive-power driven, machines.

Manuals.—In villages where fires may be few and the first cost an important consideration, the manual fire engine is still widely used. The type of engine almost universally adopted in such cases is that known as the "London Brigade" pattern, from the fact that at one time it was the principal machine used by the London Fire Brigade. The piston rods of the pumps connect to connecting-rods working upon a central rocking shaft and fitted with long wooden handles for the pumpers. The alternate raising and depressing of these handles gives the pump pistons the up-and-down movement which draws the water through the suction inlet and forces it into the air vessel and thence to the delivery outlets. The lever handles

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when in use project fore and aft of the engines, and for convenience are made to fold and lock when the engine is travelling. In the older forms of the London Brigade manual engine the pumps and air vessel are placed in the cistern below the centre of the large hose box familiar to every one, the suction inlet is at the rear, and delivery outlets are at the sides between the front and hind wheels. In the latest pattern engine these working parts are placed outside and at the rear of the hose box in the portion of the cistern projecting beyond the box. Here they are always visible, and therefore more likely to be kept in good working order, and the suction and delivery valves are exposed for examination or renewal by simply unscrewing the air vessel—the work of a few seconds only compared with hours of close work necessary to get at the valves in the older pattern engines. The pumping power of this latter type of engine is also considerably increased. As a rule, in this new pattern engine the suction inlet and delivery outlets are placed at the rear, but when desired, as is sometimes the case for drill uniformity, etc., the outlets may be placed in the old position, at the sides, without lessening the value of the improvements referred to. At each side of the cistern of the engines are projecting "pockets" designed to carry one or more lengths of suction hose, each pocket having a hinged lid, which forms a foot rest for the firemen who ride upon the top of the large hose box when travelling to or from a fire. The engine is mounted upon steel springs and mail-coach axles, with high, wood-spoke wheels, and is drawn by a pair of horses. It is constructed in a number of sizes designed according to the number of "pumpers" required to work them. The smallest —namely, the 16-men size—(worked by 8 pumpers each side) and the 22-men size are probably the most usual sizes. The former is able to throw a jet 110 feet high, and the latter a jet 120 feet high.

The need, in some cases, is felt for a machine which can be used to deal with small fires in a district without bringing out the steamer, and this has resulted in the manufacture of what is known as a "first turn-out" machine. As its name implies, it is intended to be the first machine turned out upon receipt of a fire call, and for this purpose, while comprehensive in character, it is compact in design and as light as possible to make it consistent with the requisite strength and durability. In reality

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the machine combines three different pieces of apparatus: (1) a full-size hose and implement carriage, conveying men, hose and standpipes, and other essentials for dealing with an outbreak of fire by means of hydrant streams; (2) a chemical engine with a length of stout indiarubber hose, a complete first-aid appliance for dealing with the vast majority of fires in a district without bringing into service the more powerful steamer; and—sometimes—(3) a telescopic fire escape constructed on the lattice girder principle with plumbing gear, which enables the ladders to be maintained in a vertical position when the escape is standing upon uneven ground, and safety stops, which prevents any possibility of the ladders running down in case of a mishap to the ropes, or from any other cause. The hose carriage is strongly built with steel side frames and cross girders, and is mounted on steel springs and mail-coach axles, with high, wood-spoke wheels, the hind pair having metal hubs, giving them additional strength. The large hose box which occupies a central position is of mahogany, and is fitted with a sliding lid affording easy access to the interior. In front of the hose box is placed the chemical engine, and above the latter are seats for the coachman and officer, while beneath is a good-sized box for tools, etc.; two or more firemen ride on each side of the hose box. Powerful foot brakes worked by coachman and fireman control the running of the machine, while a loud-sounding gong is provided for clearing the way.

The main ladders of the escape are formed as girders, the flanges being of well-seasoned Oregon pine united by steel lattice. These girders are connected at the back by struts, and in front by stout oak spokes. Two of the three sliding ladders are similarly designed, while the top ladder has solid wood sides. The sliding surfaces are covered with galvanised steel strip, which protects the ladder sides and at the same time strengthens the escape. The ladders are mounted upon a steel mail-coach axle, with high, wood-spoke wheels, and, when in use, the heel of the escape rests upon the ground, ensuring stability. Stout support poles or props are also hinged to the head of the main ladder for use when the ladders may be subject to any special strain. Folding levers are hinged to the front of the escape at the lower end, and these when unfolded are automatically secured in position. The ladders are extended or lowered by means of stout galvanised steel wire rope with

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drum gear wheels and winding handles. The pawls are kept in gear by a special spring handle, and the lowering of the ladder is only possible when the pawls are drawn back and held out of gear. When travelling the escape lies upon the hose carriage in a position as nearly horizontal and as low as practicable, and is firmly held at the base by the jaws at the rear of the frame, and at the head by a hook and spring lock between the coachman's and officer's seats at the front of the carriage. The wheels of the escape fall within the wheel base of the carriage, and the ladders do not project at all over the horse's back. A simple movement suffices to free the escape at the head; the head of the ladders is then raised until the wheels touch the ground, when the escape is free and ready for instant use. In this case the chemical engine consists of a strong copper cylinder of about 40 gallons capacity, tested to a very high pressure and heavily tinned inside and furnished with gun-metal mountings, lead bottle for the acid, and agitator worked by lever and handle for mixing the chemicals in the water. When it is desired to put the cylinder under pressure, the plug of the acid vessel is withdrawn by means of a bow handle and spindle, and the bottle, automatically reversing, empties the contents into the alkaline solution. An inlet for the attachment of ordinary fire hose is provided, so that after the chemical charge is exhausted the chemical hose can still be used for ordinary water. The chemical engine is based upon the well-known principle of obtaining, by the combination of chemicals, the instant generation of a powerful pressure of carbonic acid gas, which expels the mixture of gas and water with great force upon a fire. The above is a description of a "combined" apparatus, but it is obvious that, if required, a chemical engine, pure and simple, can be obtained.

Steam Fire-Engine.—A well-known type of this class is the "vertical" steam fire engine. In this engine the twin double-acting steam cylinders work directly upon a corresponding pair of double-acting pumps, the whole being placed vertically at the rear of the quick-steaming boiler furnishing the steam power.

Two piston rods convey the movement of each piston to the pump-rod, and the movement is communicated to the double-throw crank shaft by connecting rods running from a joint in the headpiece of each pump-rod. In the older form a cross

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head was used, but the new arrangement facilitates the smooth working of the machinery and minimises friction, thereby considerably lessening the wear and tear. The design of the engine ensures a steady flow of water whether at high or low pressure, and the machine works without noticeable oscillation, a very important consideration, as the vibration and movement present in some of the older types, by continually chafing the hose, materially reduce the length of time it would otherwise last.

The "variable expansion double vertical" is so arranged that the steam in the cylinders can be used more or less expansively as desired, the alteration being made by a lever and quadrant moving the cut-off eccentric strap, a pointer showing the degree of expansion. The engine is started with the cut-off at three-quarters, and when at work this can be varied to half stroke, and as the work done in either of these positions is practically the same owing to the expansive power of steam, the effect of the expansion arrangement is considerable economy in steam consumption, and consequently a saving in fuel and a reduction in the weight of the machine. For quick steaming purposes an inclined water-tube type boiler is necessary, and when used in conjunction with the aid of a quick steam raising apparatus, it is capable of raising steam from cold water to 100 lb. pressure per square inch in about five minutes, while stationary, or a short time longer while travelling, without any stoking whatever. Stoking *en route*, at the best, is neither a safe nor easy task, and is thus rendered unnecessary; the fire is lighted on leaving the fire station, or at any point of the journey without stopping, by means of a simple lighting apparatus fitted at the front of the boiler. Another advantage of using a quick steaming apparatus is that the engine starts working with a full body of fire in the furnace, and there is no risk of a temporary reduction of steam pressure when the engine commences working.

Where it is desired to use oil fuel in place of coal in the furnace—by which the time taken in raising steam under ordinary conditions is appreciably shortened — oil-burning apparatus is fitted. In this case oil is stored in an oblong tank holding from $2\frac{1}{2}$ to 3 hours' supply, placed in the forepart of the hose box under the coachman's seat, whence it is fed by gravity through metal tubes to the burner fitted within the furnace beneath the boiler. In one of the latest forms of oil-

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burning apparatus the oil is sprayed through a single outlet on to a jet of superheated steam which disperses it into fine molecules and forces it against a baffle plate in the furnace ensuring thorough combustion. When starting with the furnace cold, air forced into the boiler takes the place of the steam jet for temporarily spraying the oil until a pressure of 10 lbs. has been obtained. The supply of fuel to the furnace can be regulated as required, and should it be desired at any time to use coal, the oil-burning apparatus can be quickly removed from the furnace and replaced when required. The furnace door should be at the side in preference to the rear, the side position having important advantages, so much so that the London Fire Brigade has specified this arrangement in engines constructed for that brigade.

Briefly, the advantages are stated to be the following:—The engineer being away from the hose and suction pipe connections, and having all the boiler gauges and fittings within easy reach, can perform his work better, the position is more convenient for cleaning, oiling, etc., and the centre of gravity is kept low, allowing the engine to travel more easily and safely, the design of the engine is less cramped, and a lower position of the suction chamber is permitted, which is very useful when working from a depth.

The "double vertical" though comparatively light in weight is strongly built, steel entering freely into the construction of both carriage and frame. The parts of the machinery with which the water comes into contact are of gun-metal, bronze, or other non-corrodible metal. The engine is mounted on strong, high, wood spoke-wheels, with steel axles, springs, and side frame, and is furnished with a full-sized hose box, the lid of which forms the seats for the firemen. When fully stowed with the necessary hose and other gear and with men mounted on the engine, it can be rapidly drawn by a pair of horses. The "double vertical" is constructed in eight standard sizes, variations from these being made to suit local requirements. The capacities range from 200 to 1000 gallons per minute, the smaller size throwing a $\frac{5}{6}$-inch jet 140 feet high, and the larger size a 2-inch stream to a height of 205 feet. Even when horses are kept for the sole use of the fire engine, the time taken to get to a fire is longer than is desired by some brigades, and when the horses are engaged upon other work, or the

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horses have to be hired, the delay before starting may become serious. It is to avoid this delay that the motor fire engine has been designed. The development of motor-driven vehicles has progressed greatly during the past few years, and many districts have now adopted one or other of the various forms on the market. These engines may be steam driven, petrol driven, or electrically driven, instead of using horses, whilst the pumps may be worked by steam or petrol. For speed in travelling to a fire the motor, of course, is far in advance of the horsed machines—a most important point in "fire fighting," and the annual cost of the former compares very favourably—including repayment of principal and interest on capital—with the latter.

A type of pump which has come to the front very much of late is the centrifugal pump made by Messrs. Gwynne, of Hammersmith, and driven by an internal combustion engine made by Messrs. Dennis, of Guildford. Several towns have adopted this type of fire engine, and speak well of its capabilities. The makers of this engine claim that the centrifugal pump is superior to the reciprocating pump used on the ordinary fire engine, and that the whole of the mechanism gives the highest efficiency with the greatest simplicity—no valves, air vessels, or other complications, no converting the high-speed rotary movement of the petrol engine into the comparatively slow reciprocating one. From reports received the "Dennis-Gwynne" Petrol Motor Turbine Fire Engine bids fair to become a serious competitor with the ordinary steam reciprocating pump.

3. Calling the Brigade.

If a brigade is only provided with "up-to-date" appliances and speedy means of getting to a fire, it will still be inefficient unless there is installed some system whereby a "call" can be quickly given to every member, from any part of the district.

From time immemorial there seems to have been some method in vogue for summoning the members of the fire brigade, even in the smallest of towns. In some cases church bells were rung, and in others the town crier was commandeered to spread the news of the outbreak. Latterly we find "call boys" employed whose duty is to run round to every member of the brigade. All these methods, however, involve considerable

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delay, and a fire, once started in a district where no other quicker system is in use, would be very difficult to subdue owing to the time elapsing between the commencement of the fire and the time of arrival of the brigade. In some districts a "maroon" is sent up to call the brigade, and this arrangement may still be useful where the horses—used for horsing the fire engine—are employed on other work during the day. The explosion of the "maroon" can be heard at a considerable distance, but even this method is open to the objection that the noise of the explosion may frighten restive horses, and may not be heard when the wind is blowing from the part of the district in which the fire-horses are at work.

Certainly neither of these methods can be called "ideal."

Several systems of electric calls are in use in various towns, but it is strange that the cost of not only the upkeep of the brigade but also the cost of the necessary appliances should have to be borne by the local authority, and not by those more particularly interested, viz. the insurance companies; and what appears still more strange is that insurance companies will not, as a rule, pay for the attendance of the brigades at fires within the district of a local authority, but only when the brigade works outside the district. This is not as it should be, and the time cannot, surely, be far distant when the insurance companies will be compelled to pay for the upkeep of the brigades according to the percentage of property, within a district, insured with each particular company, or the company in which a property is insured shall pay for the actual out-of-pocket expenses for attending fires at that property.

The call-system in use may be of two kinds—viz. those used by the public for sending an intimation of the existence of a fire, and those used for notifying the members of the brigade; and as these depend upon electricity for their working, it will be as well to give a few preliminary definitions in spite of the fact that such information may appear to be very elementary.

The system of units used in connection with this matter are: 1—the unit of current, called an *ampere;* 2—the unit of potential or electromotive force, generally written E.M.F., or electrical pressure, called a *volt;* 3—the unit of resistance, called an *ohm.*

By what is known as Ohm's law, the strength of an

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electrical current in a conductor is directly proportional to the difference of potential at the ends of the conductor, and inversely proportional to the resistance of the conductor. Hence, if C = current in amperes, E = difference in potential, or pressure, in volts, R = resistance in ohms, then C varies as $\frac{E}{R}$, or the current in amperes = $\frac{E}{R}$.

The resistance of a conductor depends upon its length, its cross sectional area, its temperature, and the kind of material of which the conductor is made. It is directly proportional to its length, inversely proportional to its cross sectional area, generally increases with the temperature, and is directly proportional to the specific resistance of the material used.

To send a current of electricity along a conductor requires the expenditure of energy, and this energy is supplied from primary batteries. The question of battery power and wire is dealt with later on in this paper, and in the design of a call-system (*i.e.* one for notifying the members of the brigade) it should be remembered that the lines may be run on one of two systems, viz. the "group" or the "direct wire" system. In the "group" system one or more main wires are run overhead, or underground, connecting the various sub-areas of a district, and branch lines are run from these main routes to each of the firemen's houses. In the "direct" system a separate wire is run to each of the firemen's houses from the central or sub-stations.

Each of these methods has its advantages and its disadvantages. For instance, in the "grouped" system the call is given simultaneously to the whole of the men, whereas in the "direct" system any man may, in addition, be called up singly. In some cases a combination of the two systems may be adopted. The district may be subdivided, and those men near the station connected by separate wires, whilst those more distant may be formed into groups of two or three on one line.

The system to be adopted will, however, depend upon the amount of funds at the disposal of the authority and the arrangements of the brigade, and also upon the system of electrical calls adopted. In the case of a central fire station, where no resident fireman is employed, the "grouped" system is no doubt the one to be commended. It is simple in construction, and cheap. Where, however, a man is always in attendance at the station, then it will be advisable to have

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arrangements to call either of the firemen, as well as the whole.

The wires may be worked on what is known as the "open" or "closed" circuit system.

The "open circuit" system is so called because no current of electricity passes through the circuit while the system is at rest. Upon a signal being given, the circuit is momentarily closed and current is drawn from the battery to record the signal, *i.e.* current is consumed only when a signal is transmitted.

The "closed" system is so named because a current of electricity is always flowing through the circuit, the receiving apparatus being held out of action by electro-magnets as long as the current continues to flow. The current is momentarily broken upon sending in a signal, and the consequent de-energising of the electro-magnets allows the receiving apparatus to come into operation.

Each of these systems has its advantages and its disadvantages. In the "open circuit" system it is difficult to tell when the system is out of order, except by testing, but the system is an economical one. In the "closed circuit" system the mere fact of a breakdown is indicated at the station, but the apparatus is more complicated, and the first cost, as well as the upkeep, is greater. "Simplicity" should be the keynote of all fire-call systems. As a rule, the "call-bell" lines to the firemen are on the "open circuit" system, but the lines from fire-alarm posts may be on the "closed circuit" system.

The simplest form of "call" is probably that of the wires being run on the "grouped" system, the firemen being notified by the contact being made at a wall-box fixed outside the fire station; but this system alone is not to be recommended, as valuable time would be lost owing to the person giving the call having to reach the fire station and then waiting until the arrival of the brigade to indicate the position of the fire. An extension of this arrangement is to place call-points at certain of the firemen's houses, and indicating the position of the call by a "code of rings." A further extension is the placing of standard fire-alarm posts in various parts of the district, and so arranging the rings that the call given will indicate its position.

Type of Primary Cell.—For the generation of the electrical current some form of cell must be used, or in the case of a

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continuous current being required an accumulator may be adopted. The most common form is, however, the self-contained cell. There are many of these on the market, but the best known are "Leclanche" and the "Gravity Daniel" cell. For fire alarm purposes a primary cell should be easy of attention, and the materials should be cheap and plentiful.

In one of its forms the Leclanche cell consists of electrodes of zinc and carbon. The carbon plate is packed in a porous pot with peroxide of manganese—to act as a depolariser—and broken gas carbon, the zinc rod being immersed in a solution of sal-ammoniac. The carbon plate forms the negative element and the zinc rod the positive element. The electrolyte consists of four parts of sal-ammoniac and sixteen parts of water. To prevent the sal-ammoniac creeping up the sides of the cell the top of the porous pot is coated with paraffin wax and sealed down. The elements and the electrolyte are placed in a glass container. The attention to this type of cell is of the simplest; all that is necessary is a supply of glass containing vessels, porous pots, and zinc rods, with a quantity of sal-ammoniac, all of which can easily be obtained separately. The electromotive force (E.M.F.) of this cell may be taken as 1·47 volts, and the resistance of the standard quart cell about 1·5 ohms. The E.M.F., however, rapidly falls when used to send heavy currents, but remains fairly constant when sending intermittent currents, such as used in fire calls, arranged on the open circuit system; as might be expected, it would soon run down if a short circuit occurred on the system. The line wires are attached to the carbon element by means of a binding screw, and to the zinc element by means of a binding screw, or bound to a piece of wire projecting from the zinc.

A type of cell in frequent use is a modification of the above. The porous pot, in the type just described, creating internal resistance, is replaced by a canvas bag, and instead of using a zinc rod an almost complete cylinder or sheet of zinc is bent round the canvas bag. This type of cell has a lower internal resistance, and has a greater "current" capacity. It is known as the "Sack" cell.

For systems arranged on the closed circuit a different cell must be used, and must be one in which the E.M.F. remains fairly constant when sending a continuous current. This is very difficult to obtain when using a primary battery, and it

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has therefore, in some cases, been suggested that accumulators should be used. The type of cell, however, generally recommended with the closed circuit is the Gravity-Daniel cell. This consists of an outer glass container, on the bottom of which is placed thin copper leaves, rivetted together in the centre and having an insulated wire attached thereto. The leaves are opened out into star form, and stand on edge, the top corners being turned over. A pound or so of copper-sulphate is poured over the copper, the bending of the corners serving to anchor the copper in among the crystals, which are packed between the copper sheets. The zinc takes the form of a crow-foot with a lug projecting from the top, and provided with a hole and screw for connecting with the wire. This lug also serves to attach the zinc to the top of the jar. The copper leaves are covered at least to a depth of 1 inch, with copper sulphate, and the remainder of the jar is filled with water, until the zinc is covered for about 1 inch. The copper-sulphate solution remains at the bottom of the cell because of its greater weight, hence the solutions are kept separate by gravity. The E.M.F. of this cell is about 1·07, and its internal resistance about 2 ohms. Its current is small, but remains fairly constant in action.

Arrangement and Grouping of Cells.—Cells may be arranged in series or in multiple. When increased voltage is required the arrangement is in series—the carbon of one being connected to the zinc of the next—and the total voltage of the battery is the sum of the voltage of each cell, but the current is only that due to one cell. When increased current is required the multiple arrangement may be used—all the carbons are connected together and all the zincs. This arrangement gives the combined amperage (current) of all, but it is only of the same voltage of one cell.

As in fire-alarm work the line wires are of a moderate length and the resistance high, the voltage is the principal point to be considered, hence the general arrangement is to connect in series, as a high amperage is unnecessary. The resistance to be overcome by the battery is (1) that due to the battery itself; (2) that due to the external circuit; (3) that due to the bells. If in a single cell the current

$$C = \frac{E}{R + r}$$

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where E = E.M.F. of cell, R = resistance in external circuit, r = internal resistance of cell; and if n = number of cells connected in series, then

$$C = \frac{nE}{nr + R}$$

but as r is small in comparison with R it may be neglected—especially if the working voltage of a Leclanche cell is taken as 1·25 volts—and then

$$C = \frac{nE}{R}$$

or to develop the current which a line *can* carry

$$n = \frac{R \times C}{E}$$

It is seldom, however, necessary to consider the current to be carried, the voltage being much more important; hence the amount of battery power will depend upon the length of the wires, the resistance of the external circuit, and this again depends upon the size of the wire used.

Overhead v. *Underground Lines.*—The question as to whether the lines shall be overhead or underground is one for the decision of a particular district. Overhead wires must have some form of support, and in the more rural parts of a district these supports may not be objectionable from an æsthetic point of view, but many local authorities are averse to themselves setting an example of disfiguring the streets by the erection of poles, and, in addition to this, great difficulty may be experienced in obtaining "way leaves" for connection to chimneys of houses; in these cases underground wires would be laid, but it must be borne in mind that such a system has its disadvantages as well as advantages. Some of its advantages are: no disfigurement of the streets by unsightly poles, no way leaves necessary, inspection direct from the street without entering private property, freedom from atmospheric influences (so far as wind and snow are concerned). Some of its disadvantages are: it is costly to lay down in the first instance, and faults are not so easy to trace and rectify, and therefore cost more than the overhead system. In those districts where the question of cost is the consideration, and way leaves can easily be obtained, and no objection is raised to the use of poles in the streets, the

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overhead system is the one to adopt. Some of its advantages are: it is fairly economical in the first instance, and any faults occurring on the system are easily traced and rectified. Some of its disadvantages are: private property has in many instances to be entered to get at the attachments; it is liable to be affected by wind and snow, and also trees growing in close proximity to the wires; complaints may be received as to humming, if the line is attached to chimney stacks of houses, and faults may occur on the system due to contact with other wires and the effects of lightning.

Wood v. *Iron Poles.*—The question as to whether wood or iron poles shall be used depends upon what an authority is prepared to spend and upon sentimental grounds. In many cases wood poles are objected to from a sentimental point of view; they are considered to be unsightly, but this is a matter of opinion only. They are inexpensive to erect, but on the other hand their life is only short, viz. about seven years, and they require painting frequently. Iron poles, on the other hand, last a considerable time, require painting at much greater intervals, but are easier conductors to earth if there is a leakage in the line at the support. The wood poles, if to be painted, should be of larch, 20 feet out of ground, and about 5½ inches diameter at the top, and 7½ inches diameter 5 feet from the butt. The bottom of the pole is charred and coated with tar before "planting"; the portion above ground to be painted. Where appearance is of no consequence creosoting is the best form, as a creosoted pole lasts a considerable number of years; but when appearance is to be considered the poles may be painted. A good method is to paint the lower 6 feet white and the upper portion green; but a better method is to creosote the lower 6 feet, and "lag" it with narrow strips of wrought wood-work bound to the pole at top, centre, and bottom, with iron bands, and this lagging when painted white, and the iron bands black, gives a very pleasant effect. The tops of the poles may be finished with a turned finial to add to the effect. The cost of the ordinary wood poles, unpainted, is about 5*l.* fixed. If iron poles are used they should be tubular; they may, however, be sectional or taper poles. If joints of any kind are objectionable the latter should be adopted. They may be about 4½ inches diameter at the top tapering to 7½ inches at 9 feet 6 inches from the base, the thickness of the metal not to

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be less than $\frac{1}{4}$ inch. These poles may be painted white for a distance of 6 feet from the base, and green for the remainder of the height and finished with an ornamental finial. The cost of such a pole erected would be about 20*l*. A much more reasonable pole can, however, be used, which is of $\frac{3}{16}$ inch metal, and about $2\frac{3}{4}$ inches diameter at top and 4 inches at bottom, the cost being about 7*l*.

Attachments and Spans.—When the underground system of line wires is adopted there is of course no need to consider this question, the wires being simply laid in earthenware ducts below the footway—the wires being insulated; but when the overhead system is adopted the spans and attachments are important. The supports generally take the form of strong galvanised iron brackets and arms of various shapes attached to chimneys of houses by means of long nails, or to iron or wood poles by means of bolts and screws. When used on iron poles, the best method is to use galvanised iron tubular arms $\frac{1}{8}$ inch diameter, bolted at the centre. When used on wood poles the arms may be $2\frac{1}{2}$ by $2\frac{1}{2}$ inches oak; but for attaching to chimney stacks the brackets should be of cast or wrought galvanised iron. The position of the various attachments requires careful consideration, and must be so arranged that the line wire shall not in any part of its length—due to increase of sag or extension due to increase of temperature—touch any other object. The designing of the route to be followed therefore requires careful consideration. The route should only be fixed after a preliminary survey, as "way leaves" will have to be obtained for the attachments, and unless it has been carefully thought out it may be found, on proceeding with the work, that obstructions—such as trees, etc.—come in the way and fresh "way leaves" will have to be obtained to avoid the obstructions, causing considerable delay and sometimes an entire change of route.

The maximum span of a wire—that is, its length from support to support—will also have to be carefully considered, and also the included angle between the wires at the points of support; the longer the span the greater the sag and tension in the wires at the supports, and the smaller the included angle the greater the strain on the attachment.

Let l = actual length of wire between the supports in feet
L = distance apart from support to support in feet.
d = dip or sag in feet.

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T = tension in wire at supports.
w = weight in lbs. per foot of the wire.

then $d = \frac{L^2 w}{8T}$ $\qquad T = \frac{L^2 w}{8d}$

$l = L + \frac{8d^2}{3L}$ $\qquad d = \frac{\sqrt{3Ll - 3L^2}}{8}$

To give an illustration:—Take a No. 16 S.W.G. copper wire weighing 65½ lbs. per mile, with a span of 120 feet, the dip not to exceed 6 inches, then—

$$T = \frac{120 \times 120 \times 0{\cdot}0124}{8 \times 0{\cdot}5} = 44{\cdot}64 \text{ lbs.}$$

If the span had been 240 feet instead of 120 feet, the tension would have been 178·56 lbs. Thus the greater the dip the less the tension. The dip remaining constant, doubling the span increases the tension fourfold.

As no wire should be strained up to a greater tension than a quarter of its breaking strain, it is important that the spans, if of copper wire, should not exceed a certain length to be consistent with economy.

Where the wire runs in a continuous line, the strain on the attachments may be very little; but where the wires are arranged so that the internal angle is *towards* the attachment, then the strain is *towards* the fixing, and where the wires are arranged so that the internal angle is *away* from the attachment, the strain is on the nails; and, as many chimneys will not bear the strain, it is usual to place galvanised iron plates at the angles of the structure, and bind with strong galvanised iron wire. The smaller the included angle the greater the direct strain. In addition to this, there is the question of wind pressure and weight of snow, and such-like, which increases the strain on the attachment.

Insulators.—There are many forms of these in use, such as glass, ebonite, brown earthenware, and porcelain. The latter is the more common material, its insulating power is high, it has a smooth surface, it is vitrified throughout, it is impervious to moisture, and, as a rule, free from flaws. It gives the highest possible resistance to leakage of current. The best form is that in which the exposed surface is at a minimum, and the wire as far as possible from the insulator support, due allowance being made for the strength of the insulator.

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A good form is that known as the "Double shed" type. This consists of external and internal cups (in one piece) with a galvanised iron bolt, in the centre, for attachment to the cross arm of the pole or to the chimney fixing. It may here be pointed out that it is advisable to see that the insulator used is British make, inasmuch as there are insulators of this type on the market which, although in appearance are whiter than the British make, are not of so durable a material.

Size of Wire required.—There are several matters to be considered in connection with this question, such as the length of span, the distance between the terminals, the resistance to be overcome, the current to be carried, the battery power provided at the central station, and the fixings adopted. A wire of high conductivity should be chosen; but for overhead lines, although this is of great importance, tensile strength and durability are of even greater importance. Gauge for gauge, the electrical conductivity of copper is 6½ times that of iron; hence, if iron were used, it would have to be of fairly large diameter, but where a stronger material than copper is required, silicium-bronze may be used. Such a wire, weighing 100 lbs. per mile, and having a breaking strain 50 per cent. higher than copper wire of the same weight, has half the conductivity of copper. Where the line passes through trees and over houses, or where subject to heavy strains, silicium-bronze wire *should* be used, which should be 0·05 inch diameter, having a resistance of about 45 ohms per mile, breaking strain 200 lbs. elongation before any strain 1 per cent., and a weight of 40 lbs. per mile. For pole lines copper wire may be used, and as this material is the best, the following remarks relate to it only, and would require modification in the case of silicium-bronze. Copper wire is expensive, hence the wire should only be large enough to do its duty properly, and this is important for other materials also. The tendency is to insist upon heavy wires which, in the opinion of the Author, is a mistake. It should, however, be borne in mind that the smaller the wire the less the weight per foot run, the greater the resistance to be overcome, the smaller the current carried, and the greater the loss in pressure between the terminals. In fire brigade work, however, one size wire is generally used, the battery power and spans being arranged accordingly. Assuming the material to be copper, then the wire should be hard-drawn, high-conductivity commercial copper which will

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not elongate more than one per cent. without fracture, and weigh 555 lbs. per cubic foot at 60° F. (S.G. = 8·912). The resistance in this wire is found by using the formula

$$\frac{0{\cdot}0431689}{\text{area of wire in square inches}} = \text{resistance in ohms.}$$

A No. 19 S.W.G. wire has a diameter of 0·040 inch, area 0·001257 inch, weight 25·58 lbs. per mile, and has a standard resistance of 33·668 ohms at 60° F. The amperes it will carry, calculated at 1000 amperes per square inch, are 1·2566. The loss in potential will depend upon the length of the line and also on the initial battery power provided. A No. 16 S.W.G. wire has a diameter of 0·064 inch, an area of 0·003217 square inch, a weight of about 65½ lbs. per mile, and a standard resistance of 13·16 ohms. It will carry 3·217 amperes; so that by increasing the weight we reduce the resistance.

The leading-in wires should be as follows: Inside conductors of No. 20 S.W.G. high-conductivity copper wire, tinned, insulated with pure Para rubber strip, cotton binding, and then braided and coated with ozokerit or paraffin wax, outside conductors of No. 20 S.W.G. pure copper wire insulated with pure Para rubber and vulcanized rubber, then tapped and braided and compounded over all, or lead covered.

Protection from Lightning.—To protect the overhead lines against lightning, what are known as "lightning arresters" are used. The lines being of low potential and carrying small currents, the protection against excessive potential difference between the line and the earth is carried out by mounting two sets of points on an insulated base opposite to each other, and separated by a small gap, and connecting one set to the line and the other to the earth. The lightning effect discharges itself across this air gap, and thus protects the alarm instruments from damage. These lightning arresters are fixed at the junction of the leading-in wire and the internal wiring. Wherever earth connections are required, tinned brass earth clips should be provided and fixed to water-service pipes or to galvanised sheets. In some cases the carbon block type with mica separator is used.

Prevention of Humming.—This is a frequent source of complaint from occupiers of houses to which the overhead line wires are attached, as it gives rise to a considerable humming

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noise which, in some cases, is almost unbearable. This objection can be remedied in several ways. One method is to insulate the line wire for a short length on either side of the attachment, as previously referred to under "Attachments"; another way is to affix lead tags to the wire on either side of the attachment, and, if either of these methods fails to give the desired relief, then a short length of wire may be connected on either side of the attachment, and encase a short length of the main wires on either side of the fixing in rubber tubes, and wrap chain round to take up the vibrations.

Call Bells.—The call bells fixed in the firemen's houses should be of the best construction, 6-inch diameter bells, and mounted in polished teak cases. They may be arranged for continuous ringing or intermittent ringing as desired. A switch is sometimes provided in the fireman's house, so that in case of illness or other cause the bell may be switched out of circuit.

In those cases where the fireman resides at a great distance from the station, and the current from the battery at the central station is too weak to ring the bell properly, it is usual to fix a "relay." This consists, in its simplest form, of a battery of small power being fixed near the bell, and all the current from the central station has to do is to energise a small magnet which in turn attracts an armature and closes the circuit between the local battery and the bell; thus the battery which actually rings the bell has only to work through a few feet of wire.

Fire-Alarm Posts.—These are used by the general public for "sending" a call to the central station, and are supplied in a variety of forms, sizes, and construction. Their general appearance is well known. The posts consist of cast-iron standards, in the head of which is placed the transmitter. The door in the head is glazed, and upon breaking the glass and pulling the handle a signal may be given simultaneously in every fireman's house, as well as at the central fire station. The apparatus can be arranged for each post to give a distinct ring, so that all the firemen may know from whence the ring emanates. This arrangement saves a considerable loss of time on the part of those firemen living near the call, who may proceed at once to the seat of fire, those living near the station bringing along the engine, etc. This arrangement would not, however, be a convenience if there were many "fire-alarm" posts in the district, as the rings would be confused; hence if the town is of such a

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size as to warrant the use of a large number of posts, then the call would be sent direct to the fire station indicated on the switchboard and then be transmitted to the respective firemen by the man in charge, who would keep the records as to time, etc. In some cases permanent telephones are fixed in the alarm posts to permit of communication with the central station, or portable instruments may be carried on the engine, so that messages for more help or other instructions may be sent. In a large district a number of sub-stations would be provided. All the alarm posts protecting the sub-district would then be connected up to its sub-station, and the call is not only received by the attendant at the sub-station, but is also automatically repeated to the central station. A small town would, in the first instance, provide its brigade with a call-bell system communicating from the fire station with the firemen's houses, and as the growth of the town warranted the expense a street fire-alarm system would be installed by which the public give the call to the brigade; still further growth would warrant other various applications of telegraphy to fire-brigade purposes, which an up-to-date system provides.

A few of the better known systems will now be described:—

Stuart and Moore, Ealing, London.—The call-bell system of this firm provides communication from the fire station, police station, or other central point to the houses of the firemen. In each man's house a bell is fixed, and a transmitter is provided at the point from which the call is to be given. At the latter point also the whole of the cells are centralised. All instruments are mounted in cast-iron cases, stove enamelled, rendering them proof against dust, damp, and interference. The transmitter consists of a pendulum contact maker which, when once set in motion, transmits to the bells an intermittent signal continuing for about two minutes. The series of short synchronous rings given on the bells indicates a genuine fire call, and the calling out of the brigade by accidental false alarms is rendered impossible. In the case of more than one transmitter being connected, the nature of the intermittent ring may be varied so as to indicate the position from which the call has been sent. Each transmitter is also provided with a signalling button from which pre-arranged code signals may be given by the man sending in the call, this giving further information to the firemen or signifying "test call," etc.

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The transmitters may be mounted in cast-iron fire-alarm boxes for fixing outside for use by the public, and various forms are made for internal use. These may be placed, if desired, in the houses of certain of the firemen, from any of which points the brigade may be called out.

The wiring, which may be overhead or underground, is carried out either on the "group" system or the "direct wire" system. The former costs less and provides for calling all the men simultaneously. The latter necessitates a separate wire to each fireman's house, and a switchboard is provided at the main calling point fitted with a switch, push, and name rack for each man. The whole or any number of men may be called simultaneously, or any man may be called singly from the press button.

Call-bell telephones are or may be fitted on either form of system to the houses of any firemen to whom it is desired to communicate verbal instructions after giving the call, no extra wiring being required. When several transmitting instruments are connected it is usual to provide an indicator at the central position, upon which will be shown the number of the point from which the call has been given. This firm make a "synchronous relay" which will pass on the genuine fire call to the firemen's bells, but will not allow other rings such as may be due to contacts on the overhead wires to go through.

When there is a man on duty at the Fire Brigade Headquarters and several calling points are required in different parts of the town, the system of incoming calls takes the form of a Street Alarm System. The Stuart & Moore system operates upon open circuit, a definition of which has already been given. A number of alarm posts or boxes are set up at important spots in the town, each connected by a separate wire overhead or underground to the fire station. At the latter point a switchboard is placed fitted with the necessary apparatus for receiving, replying to and recording (if necessary) the calls.

In the case of the switchboards, the whole of the apparatus is mounted on hinged panels forming the front of a dustproof case, inside which all working parts and connections are mounted. This arrangement enables any adjustments required to be carried out with ease and dispatch by swinging open the hinged panel, while at the same time affording complete protection against dust, accidental damage or interference.

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The call of fire is given by the public from any alarm box in the usual manner, by breaking the glass and pulling the handle. "Non-interference" mechanism obviates the necessity of any detailed instructions for operation, as the signal cannot be interfered with in whatever way the handle is pulled. An indicator drops at the fire station showing instantly the number of the post operated and the name of its locality. Simultaneously the special signal denoting a fire call is sounded on the fire bell and shown visually on a grid indicator.

On receiving a fire call the man on duty at the fire station depresses the reply key on the switchboard. This causes a bell to ring in the alarm post, and in this way the man giving the call is notified that his signal has been properly received and is having attention. This firm do not recommend the use of a telephone by the public for giving calls of fire owing to the delay and misunderstanding often caused thereby. As a rule, however, each alarm post is provided with telephone apparatus, available for use upon opening the door of the post by means of a key, all keys being interchangeable.

The telephone ring is given to the station by lifting the receiver in the post, and is answered by the attendant lifting a "speaking key" numbered to correspond with the indicator which has dropped. The telephone ring cannot be confused with a fire call, and if a synchronous relay is installed it will not be passed on to the firemen's houses.

If the town is a large one with several sub-stations the alarm points in the vicinity of the sub-stations may be connected thereto and a single junction line run from each to the central. Repeating apparatus would be installed at each sub-station and a type recorder at the central. Alarms in each sub-district will then be received at the sub-station and automatically repeated at the central so that the headquarters of the brigade will have a record of every alarm received. Any number of alarm posts may be operated simultaneously without confusing the signals or losing any of the calls.

The recorder prints the number of the alarm post, the date and time of receipt of call, and the time in minutes and seconds elapsing between the receipt of call and the machines leaving the station in response to it. The records appear in letters and figures on a sheet of paper of convenient size for filing, just as if printed by a typewriter.

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The disadvantage urged against the open circuit principle is the inability to obtain a notification of a break in the circuit: in the Stuart & Moore system an automatic fault detector may be installed which gives notice of any defect in the system. There are three main classes of faults to which a fire alarm system is liable. The circuit may be broken, a "short circuit" or "earth" may develop, or two alarm circuits may get into contact. The Stuart & Moore Fault Detector is provided with four indicators, three showing "break," "earth," and "contact" respectively, and the fourth the number of the faulty line.

In case of any fault occurring, an indicator shows the nature of the fault and an illuminated number appears indicating which line is defective, at the same time a buzzer sounding to call the duty man's attention. This signal is repeated every five minutes until the fault is corrected or the defective line disconnected from the system. Meanwhile it should be remembered that only the one line is affected by the fault, the rest of the system remaining in working order.

Another feature of this system is the provision for the connection of auxiliary lines to the alarm posts—that is to say connections from private alarm systems in hospitals, factories, etc., from which, when connection is made to the nearest street alarm, direct communication is obtained with the fire station.

A further development of the Stuart & Moore Alarm System is its combination with the firm's Police Telephone System. If the fire station and police station are any considerable distance apart, auto-switching apparatus is placed at the former, whereby police calls are switched through direct to the police station without disturbing the fire station. Every police constable may obtain instant communication from the alarm posts in all parts of the town with his headquarters, and the police may also ring up any alarm post, operating an indicator which calls the attention of a passing policeman. Police calls cannot interfere in any way with fire calls, although the wiring of the system is common to the two.

The Gamewell System.—This system originated in America where it is extensively used. Of late years, however, the Gamewell Fire Alarm Telegraph Company have installed their apparatus in several towns in England. The system is worked on the "closed circuit," and as a constant current of electricity

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is required the company recommend the use of accumulators, but the Gravity Daniel type of cell is cheaper in the first instance and easier to maintain—the accumulators necessitate a certain amount of skilled attention and external electricity supply. The main principle of this system, in contradistinction to the others, is the use of a "closed circuit." Any interference with the circuit—that causes the current to cease flowing—gives a signal to each indicator or box on that circuit. It is claimed that, as it is easier to interrupt a current than cause one to flow, the "closed" system has an advantage over the "open" system, and further, that if any fault occurs on the circuit by which it is rendered inoperative the fault is indicated at the central station.

In general, the system consists of one or more circuits of copper wire, each being brought back to the central station, and in which are placed a number of street fire-alarms, situate in various parts of the district, each having a number.

The street alarm boxes are of cast iron similar to those previously described, but bearing some distinctive features. There are two kinds of boxes used, viz. the "Standard" and the "Sector" types. The "Standard" type contains clockwork with spring or weight motors so arranged as to operate a circuit breaking wheel to open and close the electric circuit a definite number of times at certain intervals; in this way indicating its own number upon the alarm bells and indicators in the indicator box. The necessary clockwork is placed in a dust-proof casing. On opening the box front a small lever is seen which, on being pulled down *once*, starts the signalling mechanism. In some cases a small handle is used instead of the lever, which on being turned—in addition to sending the alarm—causes a bell to ring in the box, loud enough to call the attention of passers-by. Directly the mechanism is started it runs on until it has completed its full number of signals, and no outside interference can stop it until it has completed them. If another box on the same circuit is started it cannot send its signals until the box first set in motion has finished, when it starts in and begins sending its own number. The "Sector" signal box is made to run with either weight or spring. In this case the lever for starting the mechanism has a much longer pull, and the weight or spring is wound up by the pull given at each alarm. Each circuit is brought back to the

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central station and connected with an instrument called an automatic repeater. This instrument is so arranged that a signal on any circuit is instantly repeated on all the circuits, but if that signal is caused by a break of the wire, the repeater, after sounding one blow on the other circuits, throws the one disabled out of service, leaving the others intact. This instrument receives the signals from any of the alarm boxes, and automatically hands them on to the indicator boxes. It also controls the various alarms given. The indicator receives the signals from the alarm boxes, and notifies the attendant by ringing a bell and by recording the number of the alarm box from which the call emanates. There is also a tape machine which records the time the signal was given, and the number of the box the signal was sent from. The company also fix an automatic line tester which tests all the circuits in the entire system, and once in twenty minutes reports to the attendant any fault on the circuits.

The above describes briefly the methods adopted for the use of the public in sending calls; the calls to the firemen may be arranged on the ordinary call-bell system previously described in this paper.

Saunders and Brown's System.—This system is worked on the "open circuit" principle. The apparatus consists of a transmitter or call point placed in a cast iron post of the usual pattern, and a receiving indicator with reply key and telephone appliances for use at the fire station. In the street box is an electro-magnetic key so arranged that when the knob is pulled the disc at the station is dropped and the bell is caused to ring continuously until stopped by a reply key. Provision is also made to distinguish rings arising from contacts or any line fault or any foreign or extraneous currents from fire-calls, also in the continuous testing arrangements, so that incipient line faults may be rectified before assuming proportions which would affect the working, at the same time improving the maintenance and prolonging the life of the operating batteries. The station indicator is fitted with a "contact discriminator," which enables the officer on duty to discriminate between fire calls and false alarms arising from contact or line wire faults.

A "galvanometer" is also placed on the switch board for keeping a continual test for leak on any of the lines. If a line fault cannot be rectified for a time, that line can be

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disconnected by withdrawing its screw plug from the corresponding terminal on the indicator, and so keeping all other call-points and all the rest of the system intact until the fault can be rectified, of course marking the one call-point out of order in the meantime. An arrangement can also be provided whereby the firemen's house-bells or call-bells can if desired be connected direct to the fire alarm-posts in such a way that when (but only when) the knob of a post is pulled, the firemen's house-bells are automatically rung, but they are not rung at all by a contact or any line fault that may happen on the wire, nor by any one signalling on the official test key. By this means it is claimed that it is possible to dispense with the services of a man on duty at night. The automatic connection can be switched off at will for testing, or at such other times as desired when there is attendance at the fire station. The telephones when fixed in the street boxes, may, if so desired, be used by any person whom the authorities choose to provide with a key (without breaking the glass or giving a fire call), and for any purpose than fire calls, such as ambulance calls, police calls, and the like, and the telephones from the posts can be switched through at the fire station to an exchange or any other place of communication. An arrangement is also provided whereby the attention of an official standing near the post can be called from the station to take a message (such as for communication during the progress of a fire) without his being required to keep a telephone continuously to his ear.

It will be noticed that the essential difference between the various systems lies in the method adopted for the use of the public for notifying the central station of the existence of a fire, the call-bell system to the firemen's houses being similar in each case.

A short time since (1910) the Author sent query sheets to various towns with a view to ascertaining the systems in use, and gives below the questions asked and the information obtained thereto. The questions were as follows:—

(1) Name the town, (2) Population, (3) Area of district, (4) No. of firemen, (5) Do the firemen reside at the fire station? (6) Description of the call system in use, (7) Are the wires underground or overhead? (8) Are fire-alarm posts fixed, and if

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so, how many? (9) What arrangements are made to avoid false alarms? (10) Capital cost of the installation, (11) If loan was obtained for same, how many years allowed for repayment, (12) Average cost of maintenance per annum, (13) Remarks.

The answers were as follows:—

Acton.—(2) 55,000; (3) 2305 acres; (4) 21; (5) Engineer only; (6) Saunders and Brown's, post office; (7) Both; (8) Fixed 17; (9) Saunders and Brown's system prevents false calls; (10) None, annual rental; (11) No loan, (12) 151*l.* 2*s.* 6*d.*

Bournemouth.—(2) 75,000, (3) 5769 acres, (4) 44 of all ranks, (5) Two firemen and two coachmen, all the remainder are volunteers and of course live out; (6) All the stations and the six officers and sub-officers are on the telephone of the National Exchange. All officers and men have electric call bells in their houses, the brigade is divided into six sections, each section having its own station and its own call system. Each station can only ring out its own section, but can communicate with the other stations by telephone. The system installed is the pendulum switch installed by Stuart and Moore, which detects a false alarm, and has worked satisfactorily. Stuart and Moore maintain under a contract; (7) Above ground; (8) Two only, as we depend upon telephone calls mainly; (9) A distinctive signal given from the posts which would not be produced by a contact; (12) 44*l.* per year for the call bells and one post, the other post rented.

Barnes.—(2) 30,000; (3) 2600 acres; (4) 20, including officers; (5) Yes, 4 of them; (6) Each man has an electric bell in his residence, all of which are in communication with the telephone room adjoining the fire-station. Each man can be called separately, or the whole together, by one turn of the handle; (7) Above ground; (8) Yes—11; (9) Each fire alarm has glass which has to be broken before the alarm can be used; (12) The system is provided and maintained by the National Telephone Company at an annual payment of 140*l.*, including firemen's bells, alarm posts, and telephone to chief officer.

Bristol.—(2) 877,000; (3) 17,311 acres; (4) 46; (5) Yes, or in houses adjacent to fire station; (6) Gamewell; (7) Both; (8) 50; (9) The system prevents false alarms, except by some malicious persons; (10) Mixed up with other fire-brigade expenditure; (11) 30 years; (12) 884*l.*

Bradford.—(2) 304,323; (3) 22,844 acres; (4) Chief officer,

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superintendent, fire-alarm instructor, 3 station offices, 3 engineers, and 33 firemen of all grades; (5) Yes, with the exception of several sub-divisional men who live in close proximity to their station; (6) The Gamewell telegraphic system worked on the closed circuit principle, and operates automatically on the handle of street call box being turned, which rings the box number on a gong in the station, and also registers the number on tape machines; at the same time an automatic clock prints the year, month, and hour and minute of the alarm in indelible ink. The type necessary for this purpose changes and adjusts itself automatically every minute. All boxes are in telephonic communication with the fire station, a portable telephone being carried on the machines for this purpose. Provision is made in this system for alarms to be received simultaneously at any number of stations which are fitted up with the necessary receiving apparatus; (7) Underground; (8) All alarm boxes are fitted to any wall or lamp; (9) By this system it is impossible to receive false alarms which are due to faults; there is a standing reward to persons giving information which will lead to the conviction of senders of false alarms; (10) Total capital cost to carry 200 boxes (68 already fitted), including 40 miles of cable, 15,600*l.*; (11) 25 years; (12) About 210*l.* per annum, including salaries, etc., current and cable repairs, which have averaged about 15*l.* per annum, all other repairs executed by staff.

Birmingham.—(2) 564,859 (1909); (3) 13,477 acres; (4) 102 all told; (6) Electric bell is fitted to each man's dwelling, which can be rung singly or simultaneously; (7) Both; (8) Yes, 78; (9) Nothing beyond enamel plate showing the penalty of the offence, namely, 20*l.* under sect. 1 of the False Alarms of Fire Act, 1895; (11) No; (12) Approximately 350*l.*; the whole maintained by the National Telephone Company; cost depends upon distance wires have to be fixed.

Ealing.—(2) 52,000; (3) 3225 acres; (4) 5 permanent, 15 auxiliary; (5) Permanent staff; (6) G. P. O. Saunders and Brown 12, Stuart and Moore 15; (7) Both, mostly under; (8) 27 fixed; (9) Stuart and Moore's being fitted with the pendulum system, it is impossible to get a false alarm, unless maliciously given; (12) On Saunders and Brown's alarms the Council pays a yearly rental of 126*l.*, and they will never become the property of the Council. Stuart and Moore's (1900), 11 fire alarms cost 980*l.*,

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spread over 7 years, including maintenance; 3 fire alarms, fixed in 1908, cost 105*l.*, spread over 7 years, including maintenance; 1 fire alarm, fixed in 1909, cost 38*l.* 5*s.* No loan was obtained. The maintenance of the 15 Stuart and Moore's alarms and 26 call bells costs 52*l.* per annum.

Hounslow.—(2) 40,626; (3) 6893 acres; (4) Officers and men —33; (5) No, only second officer and 1 fireman; (6) Saunders and Brown's; (7) Overhead; (8) 13; (9) A false alarm given through the fire alarm post cannot be avoided, an alarm given by wires brought into contact would cause the bell at the station to continue ringing until the fault was removed; (10) Cost of 12—306*l.*; (11) Paid out of revenue; (12) Maintained by fire brigade permanent staff.

Leeds.—(2) 428,968; (3) 21,572 acres; (4) 42; (5) Yes; (6) A telephone is fixed in an iron box painted red, and placed in suitable prominent positions. The communication is direct to the central station. The alarm boxes are also used to call out horse ambulance, patrol waggon, or other urgent police matters. When a call is made, the exact situation of the premises, their nature and extent, can be obtained; (7) Largely underground; (8) Yes, 22; (9) None; the door of the alarm-box may be opened by any one, and yet false alarms are almost unknown. To make use of the instrument means that the person must ring and then speak as with ordinary telephones. The system is less liable to false alarms than automatic ones; (10) The system is owned by the National Telephone Company, the Council paying a rental of 148*l.* 15*s.*

Plymouth.—(2) 120,000; (3) 2355 acres; (4) 32; (5) No; (6) Electric fire bells; (7) Under; (8) No; (9) Very rare; (10) 15*l.*; (12) 12*l.*

Twickenham.—(2) 28,000; (3) 2477 acres; (4) 15; (5) Superintendent of brigade only; (6) Stuart and Moore's Pendulum, fitted with central battery and telephone apparatus; (7) Both; (8) 12; (9) In Stuart and Moore's Pendulum System calls can only be given by breaking glass and pulling handle; (10) Total cost 330*l.*, including considerable alterations at various dates to bring the system up to date owing to growth of district; (12) Contract amount for fire alarm call-bells and street alarms, 28*l.* per annum, but additional charges, of course, made for alterations.

Tottenham.—(2) 149,000; (3) 3033 acres; (4) 25; (5) All,

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3 main and 2 sub-stations; (6) 55 street alarms, 40 telephones, 35 bell lines; (7) Under; (8) See 6; (9) None; (10) 400*l.*; (11) Various loans—10 to 15 years; (12) 50*l.* per annum.

Uxbridge.—(2) 10,000; (3) 800 acres; (4) 14; (5) No; (6) Carried out by the National Telephone Company, the system comprising call-bells at each fireman's house, and fire station may ring from police station; (7) Above; (8) No; (9) Unnecessary; (10) Unknown; (11) No; (12) Rent 20*l.* per annum.

Willesden.—(2) 150,000; (3) 4384½ acres; (4) 14 permanent and 11 volunteer; (5) Permanent at station, volunteer within easy call; (6) Gamewell; (7) Mostly underground; (8) 35; (9) System prevents false alarms, specially indicated if false; (10) Rent to G. P. O. 384*l.* 10*s.* 6*d.* per annum for 35 posts; (11) No. Remarks—Very satisfactory since 1905.

Wimbledon.—(2) 57,000; (3) 3220 acres; (4) Chief officer and 8 permanent men, 16 retained; (5) Yes—chief and 7 men; (6) Stuart and Moore's—direct from central station; group system from sub-station; been working 2½ years satisfactorily; (7) Above; (8) Yes—26; (9) Stuart and Moore's prevents false alarms, can tell if pull is a genuine one; (10) Hire-purchase system—7 years; (11) No; (12) 17*l.* 5*s.* per annum.

Wood Green.—(2) 50,000; (3) 1625 acres; (4) Captain and 13 men, 6 paid, 7 volunteer; (5) Superintendent and family movable out station; 1 fireman on duty day and night, others reside in the neighbourhood; (6) Gamewell; (7) Above; (8) 20; (9) System prevents false alarms except malicious; (10) Rented from G. P. O.; (12) Fire brigade generally 1170*l.*, fire alarms net 221*l.* per annum.

Southall-Norwood.—(2) 26,334; (3) 2576 acres; (4) 16; (5) No; (6) Stuart and Moore's Pendulum System fitted to fire-alarm posts, and call-bells in each fireman's house; means are also provided at some of the men's houses to call all the brigade as well as the central station; (7) Above; (8) 2; (9) The pendulum gives a decided ring with a true alarm; malicious alarms cannot be prevented; a contact gives a very different ring to a true alarm, and is easily distinguished therefrom; (10) The system is on the hire-purchase, for which the Council pay an annual sum of 42*l.* for 7 years, after which it becomes the property of the Council; this includes maintenance; after the 7 years the charge per annum for maintenance is to be 12*l.*

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In conclusion, the Author begs to thank all those who have willingly supplied him with the necessary information for the compilation of these notes, and trusts they may be of interest to his brother surveyors when adopting any system of fire protection for their district. As a list of firms, with their addresses, may be useful, the Author gives a few of them below:—

Fire Engines, etc.

Messrs. Merryweather and Sons, Ltd., Greenwich Road, S.E.

Messrs. Shand, Mason and Co., Upper Ground Street, Blackfriars Road, S.E.

Messrs. Dennis, Guildford.

Fire Call Systems.

Messrs. Stuart and Moore, Victoria Works, Ealing, W. (Stuart and Moore's System.)

A. C. Brown, 7 Queen Square, Finsbury Avenue, E.C. (Saunders and Brown's System.)

G. Longfield-Beasley, 10 Warwick Court, Holborn, W.C. (Gamewell System.)

National Telephone Co., Victoria Embankment, E.C. (Telephones, and, by arrangement, either of the above systems.)

The General Post Office. (Telephones, and, by arrangement, either of the above systems.)

DISCUSSION.

Mr. G. W. Lacey: There are not many of our members who are directly concerned in fire brigade management, but I happen to be one, holding, as I do, the position of chief officer of the Oswestry brigade. The paper is full of useful information, and will be of value to those who take an active part in fire brigade management, or have to lay down a system of calls for fire brigade purposes. With regard to the position of local authorities who provide fire brigades and insurance companies, there is, of course, no obligation on the local authority to provide a fire brigade; its only duty is to provide water-mains and hydrants,

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In some towns, where the local authority does not provide a brigade, the Insurance Companies have had to do it on their own account. It does seem an injustice that the Insurance Companies should get out of their responsibilities by not having to contribute towards the upkeep of the service. That is a matter that ought almost to be dealt with by legislation, for the companies reap almost the whole of the benefits. There is protection of life, which is of higher value than property, but those who undertake fire risks ought to be compelled to contribute towards the cost of the service which so largely protects their interests. The rules which Mr. Brown has given are very useful. He gives a list of retaining fees, but he does not suggest that the chief officer of the brigade should receive any fee at all. Recently my Council have dealt a little more liberally with the brigade in the matter of emoluments. We are paid 1*l.* per annum as a retaining fee and so much per drill attended, which, I think, for small towns, where there is a partially supported brigade, is a better system to adopt than to pay the men a retaining fee, independent of drills attended. I find it has kept the men up to the mark. The men one gets are usually of the artisan class, and they cannot afford to lose time for attending drills and attendance at fires, and very rightly they should be paid. With regard to the system of call bells, after a good deal of persistent effort I have been able to get all my men connected up in this way, and the advantages with such a system have been very patent. In a number of outbreaks we have been able to cope with them in the early stages, but had the old system of calling by the police at each fireman's house been in vogue, would have resulted in very large conflagrations. Mr. Brown states that the simplest form of call is probably that of the wires being run on the grouped system, the firemen being notified by the contact being made at a wall box fixed outside the fire-station. I agree with that; but he further says that this system alone is not to be recommended, as valuable time would be lost owing to the person giving the call having to reach the fire station and then waiting until the arrival of the brigade to indicate the position of the fire. I am afraid it is the only system which can be undertaken in a small town, where there are no resident firemen, and I do not see where any delay should be incurred as suggested. I have pleasure in proposing a vote of thanks to Mr. Brown for his paper.

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MR. T. CAINK: I shall be glad if Mr. Brown can tell us whether there has been any decision in the courts which fixes the liability on the water authority to provide sufficient water for the extinguishing of fires. It places a very serious responsibility upon the water authorities, as a man may take it into his head to erect works of five or six storeys in the centre of a town, and the pressure of water in the mains is not sufficient to control that building. Would the local authority be responsible for that in the case of fire?

THE PRESIDENT: I am sorry to say we cannot boast of an up-to-date fire station in West Bromwich, but the matter has been before the Council for some years, plans have been prepared, and I hope before long we shall be in possession of an efficient station. Notwithstanding that, we have a very efficient fire brigade—very prompt when at any time called upon. We have as our chief the son of a very old family of fire brigade men—Mr. Tozer. He is son of the chief in Birmingham, and his grandfather was chief at Manchester. So far as appliances are concerned, the brigade is quite up to date; indeed, this was the first town in the Midlands to instal a motor tender. We have found it extremely useful. It was made by a well-known firm, at a cost of 750*l.*, and last year when calls were made that was the only machine it was necessary to send out. It is always ready. It carries two miles of hose, a chemical engine, and everything necessary to put out a big fire if one occurs at any of the works. The idea of buying that motor tender was to be prompt on the spot in the event of fire. In a town like this, with large factories employing as many as twelve hundred persons, it is necessary to be quickly on the spot.

MR. REGINALD BROWN, in reply, said: I thank you very much for the vote of thanks accorded to me for the paper. Mr. Lacey referred particularly to the form of call on the grouped system. The form of call adopted decidedly depends upon the character of the town. Take West Bromwich, for instance. It would be absurd to put a wall box outside the fire station. That would not be sufficient; there would have to be calls at numerous convenient points. An important point was raised by Mr. Caink as to the liability of the water authority to supply water to extinguish a fire. I know of no settled case on this point. In my own district, where I had this difficulty of the mains being

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incapable of supplying the quantity of water required, we could pump the mains dry in three seconds, we certainly came to the conclusion—after taking advice—that it was the duty of the authority, in case they were pressed, to lay down a separate supply, if the Water Company were unable or unwilling to do it. I should like to see a case fought out, because it is a most important and interesting point to local authorities.

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CEMETERY CONSTRUCTION AND SUB-SOIL DRAINAGE, WITH PARTICULAR REFERENCE TO THE HANDSWORTH CEMETERY.

By H. W. BARKER, Assoc.M.Inst.C.E., *Member*.

Introduction.

When the Author, as engineering assistant to Mr. H. Richardson, Assoc.M.Inst.C.E., etc., engineer and surveyor to the Urban District Council of Handsworth, was instructed by that gentleman to prepare the scheme which forms the basis of this paper, he at once sought for information on the subject of cemeteries in the Minutes of Proceedings of the Institution of Municipal and County Engineers, but found that no paper had been submitted dealing with it. To make good this deficiency, so far as lies within the compass of the Author's attainments, this paper has been prepared.

Site.

"The soil of a burial ground should be preferably of an open porous nature, with numerous close interstices, through which air and moisture may pass in a finely divided state freely in every direction. The soil should be easily worked, it should be free from water and hard rock. A dense clay is laborious to work and retains in a concentrated state the products of decomposition. A loose stony soil may allow the passage of effluvia and of imperfectly purified drainage water.

"Public convenience requires that the site of the burial ground shall be not too far distant from the population for which it is intended, while a due regard to possible risk of injury to public health, etc., renders it desirable to avoid populous neighbourhoods and those in which building is likely to take place."

The foregoing is abstracted from the Memorandum of the Local Government Board on the Sanitary Requirements of

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Burial Grounds. The inspector under the Burials Acts has similarly reported, *vide* Brooke Little, p. 698.

It is to be feared that a local authority would have difficulty in obtaining a site complying with all these requirements, as in addition to the difficulty of finding such an one, it is not by any means every freeholder that is willing to sell land for the purpose of providing a cemetery, and it is likely to frequently occur that the local authority will be obliged to purchase a much larger area than is really needed for the requirements of their district to surmount this difficulty.

Section 10 of the Cemetery Clauses Act, 1847, which is incorporated with the Public Health (Interments) Act of 1879, provided that a cemetery is not to be constructed nearer to a dwelling-house than 200 yards without the consent of the owner and occupier; but the Burial Act, 1906, reduces this distance to 100 yards, and further provides that the consent of the owner of the adjoining land shall be deemed never to have been required in cases where a dwelling-house is or was begun or completed after land has been used or appropriated as a cemetery.

For some time prior to 1905, the Council of the Urban District of Handsworth had under consideration the question of providing a cemetery for the district, as the burial ground at the parish church was being rapidly filled up. Negotiations were therefore entered into for the acquisition of a suitable site. The Council met with many difficulties, but ultimately succeeded in purchasing the Leveretts Estate, having an area of 70 acres, at a price of 300*l.* per acre; at the same time the necessary land was acquired for widening the adjoining roads and lanes to a width of 42 feet. The preliminary examination of the site was not encouraging, for although on a hillside, the height above sea-level varying from 460 feet to 580 feet, the ground was largely found to be water-logged, and it was almost impossible to walk over the estate in its then condition. This was in some measure due to the ditches having been neglected for many years.

Size.

On administrative grounds it is required that the accommodation provided shall be sufficient to serve for the term of years over which the repayment of the loan is spread.

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The Local Government Board's Memorandum states that "under the most favourable circumstances in a stationary population it may be estimated that at least a quarter of an acre of ground should be provided for each thousand inhabitants to serve for a period of thirty years. More space will be needed if the population is an increasing one. In wealthy districts, in which many family graves are likely to be purchased, the burial ground will not be available so long as in the poor districts, in which most of the burials are in common graves."

It is to be noted that the repayment of the loan for the purchase of the land may be spread over sixty years.

In the Handsworth Cemetery, which has been in use eighteen months (May, 1911), 130 private graves have been purchased and 25 public graves used, the number of interments in the former totalling 133, and the latter 267.

Denominational Areas.

Enquiries at the other cemeteries in the locality furnished the information that interments averaged three in consecrated ground to one in the other portions. Provision has been made on this basis, the land being divided into two sections—one for the Established Church of England, and one for all other denominations.

There are certain formalities to be observed in connection with the consecration of burial grounds, which it may be of service to set out here.

The Council must, by petition under seal, apply to the Right Hon. Principal Secretary of State for the Home Department for approval to the selection of the portion of the cemetery proposed to be consecrated by the Bishop. This application has to be accompanied by a copy of the resolution directing the same, copies of the plan and certain information, as set out in the directions issued by the Home Office, *vide* Brooke Little, p. 695.

In the case of the Handsworth cemetery the fees amounted to 14*l.*

Arrangements for the ceremony of consecration have to be made with the Bishop of the Diocese, through his registrar or legal secretary.

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Graves.

The size of the grave spaces is required to be 9 feet long by 4 feet broad for adults; as only 6 feet 6 inches by 3 feet is enclosed, strips of land 1 foot wide between sides, and 2 feet 6 inches between head and feet of graves remain for use as paths, and provide access to those graves which do not abut upon the drives and paths.

Earth graves should be excavated coffin-shaped, 16 inches to 18 inches wide at head, 27 inches wide at shoulders, and 16 inches to 18 inches wide at feet. This is readily arranged by the use of hinged planks, and effects considerable saving in excavation over the usual rectangular grave.

Provision is made in the Local Government Board regulations for graves for children under the age of twelve to be 4 feet 6 inches by 4 feet, or 6 feet by 3 feet, but in practice it is found better and more convenient to construct all graves of adult size.

Contour Survey.

The Author made a contour survey of the part of the site to be laid out. From the contour plan each foot variation in level can be at once noted, the comparatively level portions being where the contour lines are some distance apart, and the hilly parts where the lines closely converge.

This plan was of great service, as it enabled the main drives to be designed to wind up the hillside along the most suitable line, and from the plan any required section was taken without further field work. The preparation of such a plan for 40 or 50 acres is a somewhat formidable task, but in the instance under consideration was certainly a labour-saving device, as it enabled alternative lines for drains and drives to be laid down and compared with no trouble.

It may be of interest to state that in preparing the contour survey (about 40 acres) some 5250 levels were taken, 4000 pegs ranged in with the theodolite, and the distance chained 16½ miles.

Subsoil Drainage.

A scheme of subsoil drainage for a cemetery is so interdependent with the consideration of the general design that

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there are a number of points to be borne in mind, outside the ordinary condition of efficiency; amongst them may be mentioned:—

1. That the drains must be coincident with the line of the drives or paths.

2. That the paths and consequently the drains, except in the case of drives laid out for the specific purpose of being ornamental or laid to curves to ease the gradient on a hilly site, should be laid approximately due north and south or east and west, as all graves must be dug east and west; sentiment and practice are very strong on this point. If the paths are made as mentioned above, the graves will be at right angles or parallel to the paths and there will be no waste of land.

3. It is also necessary to decide the method that will be adopted in making the graves. It will be impossible at any date to use the ground immediately over the principal drains, and the policy of possible future narrowing of the paths must be provided for or definitely abandoned, as this will fix the distance between the drains, which must be in multiples of 9 feet east to west and 4 feet north to south.

The Author suggests that no provision be made for the narrowing of main drives from entrances to chapel, but that allowances be made for narrowing secondary paths to 4 feet. It will be advisable at first to leave a border to each path free from graves; 8-foot paths, which are to be reduced to 4 feet, will leave a border, until such alteration, of 7 feet each side east and west and 2 feet north and south, which may be increased to 6 feet by not allowing graves to be made in the next space until absolutely necessary.

The depth of the drains will be governed by engineering consideration as to outlet; where possible it is well to allow for a depth sufficient for 5 or 6 interments in each grave. Prior to 1907 this required for five coffins 14 feet 3 inches (4 feet covering over top of coffin, plus 5 × 1 foot 3 inches, average thickness of coffin, plus 4 × 1 foot layers of earth between the coffins). By the model bye-laws issued by the Local Government Board in April, 1907, this is reduced to 3 feet covering and 6 inches between coffins, giving required depth for six coffins of 13 feet. The top of the sub-soil drain should therefore be a minimum of 13 feet 6 inches below surface of ground.

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METHODS OF CONSTRUCTING THE SUB-SOIL DRAINS AT HANDSWORTH.

At the time of the proposal to purchase the Leveretts Estate five trial holes were sunk 8 feet deep; one was quite dry, water was encountered in two holes at a depth of 6 feet 6 inches, and in the remaining two at about 2 feet 6 inches deep and in great volumes.

Subsequently a further eight trial holes were sunk to a depth of 14 feet, the report on these being as follows:—

Trial hole No. 1. Dry until 12 feet below surface; water then encountered.

No. 2. Water met at 3 feet 6 inches from the surface and the hole was sunk with great difficulty, close timbering being necessary.

No. 3. Water met at 3 feet from surface, but no difficulty was found in sinking the hole, the water-bearing strata ceasing at 5 feet below the surface.

No. 4. Water in small quantity encountered at 9 feet from the surface.

No. 5. Water in considerable quantity encountered 3 feet 6 inches below surface, water-bearing strata ceased at 6 feet below surface.

No. 6. Water encountered 3 feet below surface, and there was much difficulty in sinking the hole due to the rate at which it entered.

No. 7. Water-bearing strata from 3 feet 9 inches below surface to 6 feet below surface.

No. 8. Water encountered 3 feet below surface, below which level stratum was sandstone, and water percolated through this.

Careful returns were made of the strata as ascertained in laying the drains.

To further illustrate the changes in the nature of the sub-soil the returns of one is appended:—

From 0 to 100 feet (junction with main drain).	Vegetable soil, 1 foot 4 inches; marl and clay, 6 feet; rock and sand, 3 feet 11 inches; no water.
100 to 150 feet.	Soil, 1 foot 4 inches; blue clay and marl, 9 feet; rock sand, 5 feet 2 inches; no water.

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150 to 250 feet.	Soil, 1 foot 6 inches; blue clay, 14 feet; no water.
250 to 400 feet.	Soil, 1 foot 6 inches; marl, 3 feet 6 inches; sand, 12 feet; much water.
400 to 445 feet.	Soil, 1 foot 6 inches; loamy sand, 4 feet; sand, 11 feet; clay, 1 foot; much water.
445 to 463 feet.	Soil, 1 foot 6 inches; blue clay, 16 feet; no water.
264 to 543 feet (at foot of steep slope).	Soil, 1 foot 6 inches; blue clay, 14 feet 6 inches; little water.
543 to 570 feet.	Soil, 1 foot 6 inches; sand, 13 feet 6 inches; very great quantity of water.

A feature of the nature of the ground is that it was on some of the higher levels that the greatest volumes of water were encountered, this being due to layers of impervious material which "outcrop" against the fall of the land, and which are covered by, and overlie, sand, gravel and sandstone, of which the sub-soil of the bulk of the cemetery consists.

The sub-soil drains consist of seconds quality ordinary socketted glazed earthenware pipes; these have been laid with the spigot inserted in the socket of the next pipe, but not forced home; the lower half of each pipe is jointed with puddle, the upper half being left open. The trench is filled with puddle half-way up the pipes, which are covered the full width of the trench to a depth of one foot with screened destructor clinker; the trench above this is filled with clinker and the soil from the excavation, the clinker being brought up in the centre of the trench one foot wide. Wooden boxes were used in which to fill the clinker, the sides being next filled in and the box raised for the operation to be repeated. In timbering the trenches 18 feet "walings" were used, at the end of each "waling" the trench for a length of 2 feet was filled with clinker for its full width, to arrest and convey to the drains any water that might have a tendency to flow on the outside of the centre clinker filling.

Subsidiary drains.—On some parts of the site, underneath the water-bearing strata there is a considerable thickness of marl, so that a grave on the line of flow to the sub-soil drain would fill with water to the level of the pervious stratum; to obviate this difficulty, when a grave is opened in such a position,

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a heading is driven to the sub-soil drain and pipes laid to the grave, these being extended from grave to grave as required. This is working most satisfactorily and the expense is small.

Size of Pipes.—In order to ascertain the flow from the site the water courses were carefully gauged over rectangular notches, and pipes provided sufficiently large to take the surface water from the drives and paths in addition to the sub-soil water from the whole site. The capacity of the drains was calculated on Messrs. Santo Crimp & Bruges' formula.

Manholes.—There are manholes on the main outfall drain at the junction with the principal branch drains, and the bottom of these are constructed as catch-pits to arrest the silt which finds its way into the drains.

Total cost of the sub-soil drainage, 4470*l.*

In connection with the sub-soil drainage works two pools were drained and filled up with surplus excavated earth, and, in connection with an exchange of land for straightening the northern boundary, a new drinking pool for cattle was provided. The cost of the latter was 73*l.*

Fencing.

Section 15 of the Cemeteries Clauses Act, 1847, required a cemetery to be enclosed by a wall or fence of the height of 8 feet at the least, but section 10 of the Burial Act, 1900, repealed this regulation, and it is only requisite that the burial ground shall be effectually fenced.

The Handsworth site is enclosed with unclimbable iron fencing 8 feet high, surmounted with barbed wire carried on curved standards. The vertical bars are of cruciform section. The fencing cost 11*s.* 4*d.* per yard run.

Entrance Gates.—At the Oxhill Road Entrance, ornamental iron entrance gates have been erected, the carriage gates being 17 feet 6 inches wide, and there are two hand gates each 4 feet 3 inches wide. The gates, pilasters, and some 120 feet of ornamental fencing adjoining, cost 273*l.*

Landscape Gardening.

In order to obviate any risk of contamination, with decomposing matters, of the ground air and sub-soil water in the neighbourhood of the burial ground where houses may be built,

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a strip of ground of a minimum width of 15 feet should be reserved free from interments around the whole burial ground. In addition to the advantage of this on sanitary grounds the public have been led to expect that a cemetery will be laid out so as to be pleasing and provided with ornamental shrubberies and flower beds; the strip reserved should be utilised to provide these. Avenues of trees may be provided along the line of drives and paths, and flower beds at prominent points. The cost of the landscape gardening at Handsworth was 1086*l*.

Road-making.

In laying out a cemetery the one thing above all others that the designer should strive to avoid is the creation of what may be called "back land," which will be unpopular and of little commercial value. In order to obviate this on the Church of England portion of the Handsworth cemetery advantage was taken of the drop from one field to the next near where the Chapel is now built (the difference in level was intentionally accentuated in forming the chapel plateau) to introduce a stone terrace leading to a road 18 feet wide. This forms quite a feature, and the ground on either side, which without the terrace would have been somewhat "back land," has at present proved to be the most sought after in the cemetery. The steps consist of a flight of thirty York stone steps 18 feet wide, bordered by pierced ornamental parapets of Derbyshire stone. The Handsworth cemetery is so situated that two entrances have been provided each serving distinct parts of the district, and the funeral carriage drives form a continuous road through the middle of the site. The main drives are 25 feet wide, and are formed, on a foundation of 8 inches of destructor clinker, of a 4-inch layer of calcareous sandstone rock obtained free of cost from the spoil bank of the Sandwell Park Colliery Co., Ltd. This was broken to a 2½-inch gauge, and when in position this was given a light coating of distilled tar and topped with 2½-inch layer of tarmac, 1½-inch gauge, with ¼-inch to ⅜-inch limestone chippings as binding. The service road, which is 18 feet wide, is formed of Rowley ragstone tarred and bound with granite chippings. The paths are formed of 3 inches of gravel, obtained on the site, on a foundation of 6 inches of destructor clinker.

All drives and paths have concrete edging tiles, 8 inches

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deep and 2 inches thick, obtained from the Council's destructor works at a charge of 8½*d.* per yard lin. These prevent the down-trodden grass-verges so often seen, and are not at all unsightly, the turf being laid to their outer edge. The drives have channels composed of four rows of 3-inch limestone cubes, and on the steep gradients the gravel paths have similar channels three rows wide. The gullies are all of a deep pattern and provided with dirt boxes. Those on the main drives are of iron, with gratings 15 inches by 12 inches, and are 24 inches deep, and cost 28*s.* 6*d.* each. Those on the gravel paths are of earthenware, with iron gratings 9½ inches by 9½ inches, and are 18 inches deep, and cost 7*s.* 5*d.* each. The gully connections are cement jointed. The cost of constructing the drives and paths was 4500*l.*

Water Supply.

There should be a supply of water available for the use of visitors to the cemetery when tending graves. At Handsworth there has been provided 6 water stands fitted with Glenfield spring taps. The cost of the water service was 212*l.* (including 185 yards of 4 inches diameter fire main, 69*l.*).

Chapel.

Under the provision of section 25 of the Cemeteries Clauses Act, 1847, which was incorporated in the Public Health (Interments) Act, 1879, it was obligatory, if a part of the cemetery were consecrated and part left unconsecrated, for the local authority to build a chapel on the consecrated part. The local authority was also empowered under section 36 to build any chapel or chapels upon such unconsecrated portion, and to allow burial services therein other than the service of the Established Church of England. By section 2 of the Burial Act, 1900, the obligation of a burial authority to build a chapel within the consecrated part of a burial ground ceased, and the power of a local authority of applying moneys towards the provision of chapels is limited to the erection of a chapel on the unconsecrated portion of the burial-ground, which is not to be consecrated nor reserved for the exclusive use of any denomination.

It is most desirable that the chapel should be placed in a

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central position, and local authorities are well advised to incur a somewhat considerable expense in building the chapel, which should preferably be designed by an ecclesiastical architect, for it must be recognised that there has passed over the public mind a great change in sentiment as to the kind of structure into which bodies of the departed should be brought. The average cemetery chapel is dull, cold, and depressing; it should be, so far as possible, the opposite of that, and be such a building as to inspire that reverence due to the dead that is advocated by the leaders of all denominations.

A point requiring careful consideration is the size and seating accommodation of the chapel, and attention may be drawn to the fact that provision has to be made not only for an occasional largely attended funeral, but also for the accommodation of the mourners at the public reading time when in a town of say 100,000 inhabitants there may be on occasion twelve, or even more, funerals taking place simultaneously.

If the local authority decide to erect an expensive chapel it becomes a duty to provide a site such as to give it a setting worthy of it.

With this end in view at Handsworth Cemetery a circular plateau has been formed 240 feet diameter, giving a carriage-way of a minimum width of 45 feet, surrounded by turf borders 10 feet wide, and further by flower-beds 15 feet wide.

The chapel is in the style of English fourteenth-century Gothic architecture, and has been erected from the designs of Mr. W. H. Bidlake, M.A. It is built of brindled brick and Ridge Park stone on the exterior, and of buff brick and mottled Hollington stone in the interior. The roof is covered with Precelly green slates.

The building presents in the interior a large oblong hall, 80 feet by 26 feet, terminated toward the east by a polygonal apse, and lighted by traceried windows of varied designs. Standing some 3 feet clear of the walls on each side are slender stone columns, which extend round the apse, and at the height of 21 feet support an elaborate ribbed lierne vault, such as is popularly associated with a cathedral interior.

At the intersection of the stone ribs of the vaults are bosses, about one hundred in number, ornamented with carving symbolic of the Christian faith, and the virtues of the Christian life.

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The seating, which is of oak, will accommodate 170 persons, and is arranged in four blocks of three seats, each in rising tiers parallel to the walls, and with a wide central aisle after the manner of a college chapel. The walls behind the seats are lined with oak-traceried panelling.

A shallow transept intersects the chapel midway, in the north bay of which is an oak pulpit, in a corresponding position on the south side is the prayer-desk. A vestry adjoins the apse on the north side, which is being used as an office pending the erection of the registrar's house and offices. The paving of the chapel is in squares of Westmorland green slate and York stone.

It was formerly the custom to bring the coffin within the chapel; nowadays, for hygienic reasons, and to preclude the possibility of the spread of infection, the coffin is isolated during the service. An octagonal mortuary, sufficiently spacious to hold sixteen coffins at one time, is placed at the west end of the chapel, into which it partly projects and from which it is separated by a stone screen of three traceried windows, which allows of the coffin being seen from the chapel. The mortuary is independently lighted, and from the panelled timber ceiling a ventilation shaft is carried up above the roof of the chapel.

The entrance doors of the chapel and mortuary are placed side by side on the south with corresponding exit doors on the north side, so that the procession of mourners can readily reform behind the coffin as it leaves the mortuary for the grave. Over the entrance door is carved on a stone band the beautiful dedicatory inscription so frequently occurring in the early Christian catacombs of Rome, "Vivas in Deo, pax tecum." In a corresponding position over the north door is the inscription, "Dies mortis vitæ æternæ natalis."

Over the mortuary, which extends to only half the height of the chapel, is an octagonal organ gallery. Turret staircases lead to the organ-chamber, and to the ringing chambers of the towers, as well as to the roof. In the north tower is the tolling bell, and a smaller bell, for ringing at the hour of closing the cemetery gates, is hung in the south tower.

A heating-chamber and fuel-store, as well as public lavatories, are provided in the basement, and are approached by outside steps at the west end. Cost of chapel, 5494*l.*

Care should be taken to avoid more than one step into the

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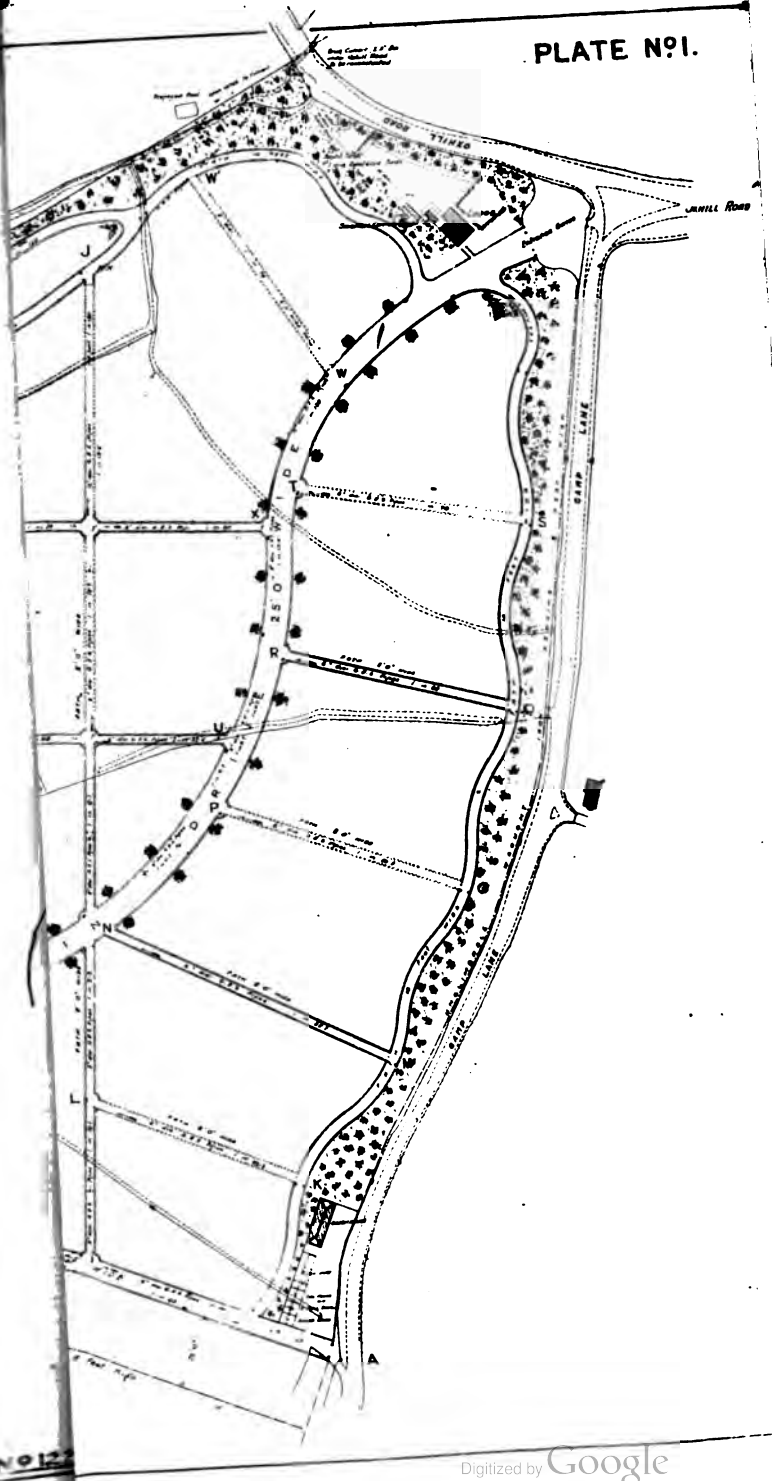
PLATE No1.



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mortuary, as more than one are awkward to negotiate, especially when there are a number of coffins already in the mortuary, and frequently a wheel bier is kept.

It will be found of great service to have storage accommodation in the basement of the chapel for ropes, sawdust, coke and some of the tools. If possible, there should be a room in the chapel, *e.g.* under the belfry, in which the men may keep their coats. The room should be provided with hot-water pipes from the general heating apparatus.

Entrance Lodge.

At the Oxhill Road entrance a lodge has been erected of brindled bricks, similar to those of the chapel, with stone mullioned windows and stone-coped gables. It contains two living-rooms, three bedrooms, and a bathroom, and the usual subordinate rooms and offices.

This lodge was designed by Mr. Bidlake. Cost 545*l.*

Service Buildings.

The service buildings are within an enclosed yard, and comprise:—

Foreman's cottage, controlling the back entrance and service road of the cemetery. The cottage has an entrance hall, two good rooms and pantry downstairs, and three rooms and bathroom on the first floor. A feature of the cottage is the metal ladder tape partitions, which are 2 inches thick, and are fireproof and hygienic. Cost of the partition was 3*s.* 8*d.* per super yard.

Stable, 16 feet by 9 feet 3 inches. The walls are lined with pressed Staffordshire blue bricks set in cement; it is lighted by four roof lights made to open, ventilated back and front with adjustable ventilators, and fitted with a Boyle's foul-air extractor. The floor is paved with Enderby cubes.

Workmen's messroom, containing a large cupboard, in which the men keep their uniform coats, etc.

Cartshed and timber store, 30 feet by 16 feet 9 inches, which is also used as a carpenter's shop.

Tool and fodder stores.

Workmen's conveniences and other outbuildings. Cost of the foregoing and boundary wall 641*l.*

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A plant-house, 30 feet by 16 feet, with two ranges of cold frames, each 30 feet long and 5 feet wide, in which to raise plants for the decoration of the cemetery. Cost 150*l.*

Public Conveniences.

Public conveniences, with three w.c.'s for women, and two w.c.'s and urinal range for men, have been provided near one entrance, in addition to the conveniences in the basement of the chapel.

Foul Water Drainage.

The cemetery is situated outside the existing sewerage system of Handsworth, it not having been extended in the direction on account of mining operations.

Two small sewage disposal installations have been constructed, one for the lodge and public conveniences, the other for the service buildings, chapel conveniences, and also for the Leveretts House.

The installations comprise covered septic tanks, designed to hold 24 hours' flow, and bacteria beds with Farrer's distributors. The media is broken blue brick, graded as follows: bottom layer 1 foot deep, 2 inch to 1 inch gauge; imtermediate layer 3 feet deep, 1 inch to ½ inch gauge, and top layer 6 inches deep, ½ inch to ¼ inch gauge. The size of the latter bed is 18 feet by 8 feet.

The cost of the drains, manholes, and disposal works was 385*l.*

Direct Labour.

The Handsworth Council decided to carry out the subsoil drainage by direct labour, and the Author, acting under the instructions of his chief, was placed in charge of the undertaking, engaged workmen and purchased the necessary plant.

This method had the advantage that the work was carried out to suit the changing local conditions of nature of subsoil and situation, and the whole of the incidental works connected with the undertaking, for many of which it would have been inconvenient to provide in a bill of quantities.

The Council purchased a portable railway to remove excavated earth to fill up the lower portions of the land. It

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consisted of about 650 yards of 20-inch gauge track (cost per yard, 2*s.* 3*d.*), 18 double side-tip waggons (cost 5*l.* 7*s.* 6*d.* each), with cross-overs, turn-tables, etc. Total cost, 199*l.* 11*s.* 5*d.* At the completion of the work the railway was sold and realized 71*l.*

The Council was so satisfied with the direct labour work of the subsoil drainage that it was resolved to also carry out the road-making, landscape gardening, and foul-water drainage by the same method.

Unemployed.

At the request of the Local Distress Committee arrangements were made to provide work for "unemployed." To put men whose usual occupation is not navvying to work in a "gang" is to court disaster, and so employment was offered them as piece-workers and consisted of screening gravel, 4*d.* per cube yard each side the screen being paid. Other piecework was filling the portable railway waggons with surplus earth from the trenches and surface excavation, the rate of pay was 2½*d.* per waggon (⅔ cube yard capacity), and stone breaking to a 2½-inch gauge, 1*s.* 10*d.* per cube yard being paid. The wages earned varied from 4*d.* to 5½*d.* per hour.

Grave Plans.

Plans must be provided to a scale sufficiently large to indicate clearly each grave space. As these plans are much used, care should be taken in their preparation to do the work in a systematic manner; a good way is to divide the site up after the manner of ordnance sheets in preference to preparing a separate plan for each plot. Before the numbering is commenced the graves should be plotted out for the whole site.

The Handsworth plans are drawn to a scale of 16 feet to 1 inch.

Uniforms for Grave-diggers.

Although not within the scope of construction, it may be of use to mention here that loose long black overcoats and silk hats should be provided for the grave-diggers for use when assisting at funerals. The coats cover up their soil-stained clothes and are more in keeping with the solemn occasion.

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Uniforms should also be provided for use on Sunday and when there is an important funeral.

TABLE OF PRINCIPAL ITEMS OF EXPENDITURE.

Land, 70 acres at 300*l.*, and Leveretts House and 3 Cottages	£21,202
Subsoil drainage (40 acres)	4470
Foul-water drains and sewerage disposal works	385
Road and path making	4500
Landscape gardening	1086
Fencing	1428
Entrance gates	273
Chapel	5494
Lodge	545
Service buildings	641
Plant-house	150
Public conveniences	82

CONCLUSION.

In conclusion, it may be remarked that the statements made in the paper are the result of the actual experience gained by an intimate association with the scheme from its inception, on the ground throughout its construction, and close personal contact for eighteen months with the actual use of the cemetery as such. The work being carried out by direct labour has enabled the more suitable of the alternative ideas that occurred in the design, upon almost every point, to be adopted.

As sanitarians, the members of the Institution may be disposed to deplore a large expenditure in the provision of a cemetery. At Handsworth, the total outlay is some 42,000*l.*, although there is an excellent crematorium a few yards over the district boundary on Lord Calthorpe's Perry Barr estate. But the general public has not yet seen fit to abandon the old form of interment and to adopt cremation.

The Author desires to acknowledge his great indebtedness to his chief, Mr. H. Richardson, A.M.Inst.C.E., who was responsible to the Handsworth Council for the design and workmanship of the cemetery, for permission to write the paper, and for valuable help in its preparation.

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DISCUSSION.

MR. J. S. BRODIE: In all cemetery work, it is essential that we should get land suitable for interment purposes. There is land and land. There is land such as stiff clay, which is very unsuitable. Then there is rocky land; we do not want the cemetery staff to have to do quarrying. It is necessary to have an open, porous subsoil if we are to make cemetery work a success. I have seen cases in which coffins have had to be lowered into one or two feet of water on wet, stormy days, which, of course, is not pleasant for the relatives of the deceased person to witness. Therefore, it is necessary to have suitable subsoil, and that soil should be properly drained. The Author lays special emphasis on good subsoil drainage, and that is a thing which should be very carefully attended to. My practice has been to make subsoil drains 12 feet in depth for graves 10 feet in depth, in order that there should be very thorough drainage. I have always laid out surface-water drains comparatively shallow along the footpaths. You have a good deal of sentiment to deal with, and there should be great care taken to guard against any damage being done to flowers or shrubs on the graves of those who are interred. I think one of the great mistakes in our cemetery practice goes on after the surveyor has practically completed his work; that is very often the unsuitable way in which tombstones are allowed to be put up. If there was a little consideration given to that, and a little forethought exercised in regard to the style, and some uniformity or harmony, it would conduce greatly to the appearance of most cemeteries. I have pleasure in moving a vote of thanks to the Author.

MR. F. R. PHIPPS: I would like to second the vote of thanks to Mr. Barker. I am just laying out a new cemetery, although not on the scale of the one described in the paper. Instead of being able to provide a chapel, at a cost of 5500*l.*, one has to be content in a small district with spending 700*l.*, and to design it one's self, instead of having an eminent architect like Mr. Bidlake to do it. The works show evidence of very great care throughout, and Handsworth is to be congratulated upon the result. I would like to know whether there has been any difficulty from providing only one chapel. In the old days a chapel was provided for the Church of England and one for the Nonconformists. Under the new Act only one is

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provided by the Authority for the use of all denominations, and if any particular denomination require a separate chapel, they must themselves provide the cost. The Church of England usually requires the chapel to be a little more ornate than some of the other denominations care about, and trouble sometimes ensues. I presume, with an architect of Mr. Bidlake's eminence, that he has been able to please all parties, and get over this difficulty, for the chapel is decidedly ornamental. Very great care and skill have also been displayed in meeting the difficulty of subsoil water, and the description of the methods used will be of advantage to those who have to deal with it. Fortunately, in Basingstoke we are on the chalk, and have not had any subsoil water to contend with.

MR. C. LUND: We recently, in Cleckheaton, purchased 16 acres of land for a cemetery, and laid 6 acres of it out. I see that practically the chapel here has cost as much as we have spent on the whole cemetery. I suppose the districts here are richer than we are in the North. It is necessary that the scheme of draining the subsoil should be carried out. My subsoil was clay and rock, and we found while in some parts of the cemetery it was quite dry, in others it was waterlogged. I have put a deep subsoil drain in under the footpaths at a depth of 14 feet, and tapped the water by that means. I have filled to within 2 feet of the surface with clinker from the destructor, and it works very well indeed. As to the chapel, we have had no difficulty at all in providing only one chapel.

MR. H. RICHARDSON: Before the discussion is closed, I should like to thank Mr. Barker for the very great assistance he has given to me personally, to Handsworth in general, and for the conscientious manner in which he has carried out this work. I would only wish to add that I have had one or two applications from members to visit the cemetery. The programme of this meeting is a stupendous one, but if a party could be made up to visit the cemetery, Mr. Barker or myself would be very pleased to accompany them, and I think they would be very pleased with what they will see there. It is very close to the West Bromwich boundary.

The vote of thanks having been unanimously accorded,

MR. BARKER, in reply, said: I beg to thank you very much for your vote of thanks. With regard to Mr. Richardson's remarks, much as I appreciate them, I am almost sorry he spoke

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of me in the very kind way he did, as I feel the indebtedness is due not from Mr. Richardson to me, but from myself to Mr. Richardson; as my opportunity to prepare my paper was entirely due to him, and I am anxious to acknowledge his valuable assistance in this and in many other directions. I want to take this opportunity to refer to a point which appears to me of importance at a time that we hear of two points of view connected with the Institution. One section appears to consider that the Institution must keep up the standard of quality at the sacrifice, if need be, of quantity, and the other section considers that, if we are to do good to the profession in general, we must increase our numbers. It appears to me that both these objects would be attained if all the present members holding chief appointments would follow Mr. Richardson's example and urge their assistants to qualify by passing our examination, and make, as he does, the holding of the testamur a *sine quâ non* for advancement in their departments. And, further, point out the advantages to be obtained by attending the meetings, and give their staffs facilities to do so, and make their own and all other juniors welcome and comfortable when at a meeting. I beg to repeat the invitation I gave in reading the abstract of my paper to visit the cemetery, one entrance to which is about a minute's walk from the West Bromwich and Handsworth boundary.

Some seventy-five members visited the cemetery after luncheon on Thursday, July 6, 1911.

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HIGHWAY IMPROVEMENT & MAINTENANCE.

By H. P. MAYBURY, M.Inst.C.E., *Member*,
County Engineer and Surveyor, Kent.

That the Council of our Institution is alive to the increasing importance of the subject of the improvement and maintenance of highways is evidenced by the action taken two or three meetings ago, when a special roads committee was appointed to deal with all matters relating thereto. This committee commences its existence under auspicious circumstances, having happily selected as its chairman the then President of the County Surveyors' Society, and a much esteemed member of this Institution. With the recurring international congresses it should be the duty and pleasure of the Council to see that in future the Institution takes up its proper and representative position. In the ranks of the Institution, as in no other, are to be found executive officers having charge of many thousands of miles of main and district roads, and who, therefore, are more in touch with present-day methods and requirements than any other society or institution, however eminent, can possibly be. The Author hopes, therefore, that in this matter the Institution will assert itself, and that by the loyalty and co-operation of its members, Government Departments, both at home and abroad, will be brought to realise that for up-to-date knowledge upon the maintenance and improvement of highways they will be well advised to apply only to this Institution. We must no longer, however, treat this subject as a side issue of little or no importance to the Institution. Our roads have become an immense national asset, carrying with it a corresponding liability.

Our annual road bill is an ever increasing one, and to-day cannot be far short of 20 millions sterling for repairing about 230,000 miles of roads and streets. How little thought is given to the national value of this wonderful network of

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highways which we have inherited, 230,000 miles! What an amazing estimate would be produced if we proceeded to deal with these roads under the provisions of section 150 of the Public Health Act of 1875 or of the Private Streets Works Act of 1892! Twenty shillings per yard lineal would represent a capital outlay of upwards of 400 million pounds sterling. How few realise this enormous latent wealth!

Sir John Macdonald, the Lord Justice Clerk of Scotland, speaking recently to a meeting of automobilists, said: "The money value of good roads to the nation is enormous. What is inefficient is never in truth cheap. And in no instance is this fundamental maxim more certainly true than in the case of roads over which a large traffic passes. Make haulage easy and swift, and at once the conveyance of material of all descriptions being cheaper, the price in the competition market for sales will necessarily fall. Locomotion will always be cheaper on good roads than bad, and this directly constitutes an addition to the wealth-producing power of the country, diminishing the cost of wear and tear of animals and carriages, and the expense of journey to travellers, by facilitating and accelerating the rapid transaction of business by intercommunication between one place and another." It would be conducive to nothing but good if this sound logic could be instilled into the minds of the members of our local governing authorities, many of whom, disregarding the advice of a distinguished statesman, still refuse to think Imperially.

The passing of the Motor Car Act came at a most inopportune moment, following as it did closely in the wake of the Education Acts, which have been the means of imposing such heavy and unpopular charges, particularly upon the county ratepayers, making it increasingly difficult for the road engineer to obtain the necessary enlarged votes for road improvement and maintenance. The incidence of charge for many of the services now put upon the ratepayer as distinguished from the taxpayer is manifestly unfair, and in no case is this more pronounced than in the charge for the maintenance of main roads. Before the days of the self-propelled high-speed motor, the use of these roads was largely confined to residents within the administrative area, and, therefore, it was not unreasonable that the cost of maintenance should be borne by the area of user.

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How different to-day! We have comparatively small and poor counties rated to maintain and improve highways, to serve the high-speed vehicle, which, in the course of an ordinary day, may traverse as many as a dozen counties, the owner of the vehicle contributing nothing to the rates of any of them. It may be said that this is a question of high policy, and that the road engineer need not trouble himself as to where the sovereigns are to come from in sufficiently increasing numbers to enable him to satisfactorily maintain and strengthen his roads. The engineer, however, knows that the extent and capacity of his coat must be limited by the cloth available from which to cut it, and in forming his requisitions, he must, and does have regard to the possibilities of his local chancellor of the exchequer.

The Author suggests with some confidence that our new roads committee would be profitably employed in duly considering the question of equity and incidence of charge, with a view to obtaining information, if necessary based upon actuarial calculation, which, at the proper time, might be useful in enabling the Institution to put forward its views in a concrete and concise form to the Royal Commission which it is proposed to constitute to inquire and report upon the whole subject of local taxation in its relation to national services and requirements.

The intensity of wear upon our highways is likely to be more severe as the use of the motor becomes more general. The increase in the United Kingdom in the number of these vehicles in the year ended the 31st December last was no less than 36,925, and this rate of progress is more than likely to be maintained. The number of these machines upon the roads, as compared with previously horsed vehicles, bears no proportion to the relative mileage of travel.

Lord Montagu writing early in the year in "The Car" showed that the petrol used in the year ended 1910, and upon which duty was paid, was sufficient, at 15 miles travel per gallon, to represent a journey of 600 million miles.

Now what are we municipal and county engineers doing to meet the requirements of this revolution in traffic? With the comparatively small amounts of money available, it is of the greatest importance that we advance upon sound lines, and that we see that good value is obtained for our expenditure and

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care. Upon most of our main trunk roads the water-bound method of repairs is doomed to disappear before another decade is reached, solely on account of cost, and no doubt some form of bituminous-bound surface will be generally in the ascendant.

Fortunately we have as distinguished members of this Institution men whose names are universally revered, and who are recognised as pioneers of the new methods. The Author, of course, refers to Messrs. J. A. Brodie and E. P. Hooley, both of whom deserve well of their day and generation. Many of us have endeavoured to follow the course these gentlemen have pointed out, and with more or less success.

Pitch and tar continue to hold the field for the present, largely on account of their comparative cheapness, but gas makers and tar distillers should realise, before it is too late, that it is quite possible by exorbitant charges to compel the road engineer either to limit his demand, or to discard the use of tar for some of the many forms of asphalte now on the market, and which, whilst being slightly more expensive than tar at the outset, have at least twice the efficiency of that product. In the south of England, where the demand for tar has been the greatest for road treatment, the purchaser is being most severely penalised. In the early days of surface painting, crude tar could be purchased in unlimited quantities at 1*d.* a gallon. To-day for the same material from the same source the charge is 3*d.* In the year ended 31st March last the tar painting bill in the County of Kent exceeded 21,000*l.*, at least half of which sum was paid for tar. To-day in the neighbourhood of London we are paying 50*s.* a ton, whilst the market price in the Midlands and the North is not more than half that figure. The difference is not accounted for by the superiority of the tar produced in the south, but is the penalty put upon us for having made a market. It is questionable whether the use of tar at any such price can be justified, and the outcome may well be, that the road engineer will prefer to transfer his patronage to a product having asphalte as its base.

The Author would (as a member of the Institution of Gas Engineers, and as one much interested in the success of that industry) take this opportunity of appealing to controllers of gas undertakings to do what they can *now* whilst they are in possession of the trade, to encourage the extension of the use of tar for road treatment, rather than to exact the last farthing,

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and by doing so compelling us to use a slightly more costly but undoubtedly a far superior product. There cannot be any question to-day as to the efficacy of tar painting in the abatement of dust, and, incidentally, as to the advantage maintenance derives therefrom. An incentive to the extension of the movement will no doubt be afforded by the Road Board's recognition of the work as an "improvement" to which they will contribute. To all users of the roads tar treatment is a great comfort, and to owners of motor-cars with pneumatic tyres it may be considered a gilt-edged investment.

The recent dry month of May gave some of us an object lesson of what flint surfaces would be like under present traffic conditions without the use of tar. They would be absolutely dangerous and ruinous to tyres. During the last two or three years the use of tarred macadam has increased enormously, and it is possible now to be reasonably sure of a successful issue from the commencement of operations.

In the present financial year, the Author has estimated for the use of 32,000 tons made of Kentish Ragstone. This material is being laid 4 inches thick and consolidated to about $2\frac{3}{4}$ inches. After completion, it is surface-painted and dressed with fine grit or chippings, and the Author is hopeful that with annual re-dressings at a cost of, say, $1\frac{1}{2}d.$ per super yard, a smooth impervious and comparatively dustless surface will be maintained. Pitch grouting is another system which can be justified upon heavily trafficked roads, and the advantage of this method is that the best and toughest granites and whinstones can be used.

To these works of improvement, as distinguished from ordinary maintenance, the Road Board will make a contribution towards the extra cost, and as the life of the surfaces so treated may reasonably be expected, under identical traffic conditions, to be much in excess of those for ordinary water-bound macadam, it would appear to be sound to take the grant from the Board, and endeavour to find the balance by an increased immediate demand upon the rates. These grants, however inadequate, must and do stimulate our authorities in carrying out works of improvements which would, without them, be indefinitely deferred. The Road Board policy and the conditions imposed have been much criticised, many Councils desiring to have a certain sum of money handed over in direct relief of rates, overlooking the fact that, however willing it may be, the Board

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is debarred by statute from making any such contributions. If the Board had done nothing else to justify its existence, the Author believes that the issuing of general directions and specifications for surface-tarring and kindred works would have been in itself sufficient.

The information thus disseminated is the first attempt for general guidance of a standardisation of tars and other products, and is the crystallisation of the best known and most successful modern practice. Every care has been taken in the compilation of the specifications to eliminate anything of an injurious nature, and which might, conceivably, be prejudicial to animal, vegetable, or fish life, and at the same time to make for the greatest permanent value to the road's surface. It is not by any means suggested that this specification is the last word upon the subject. On the contrary, it is hoped in the light of subsequent experience to revise the specification from time to time, and by this means make for better results and more uniformity of practice.

For many years past endeavours have been made by various processes to determine the relative values of road stones, and with more or less success. In this connection the name of Mr. Lovegrove will always be associated, and he is to be congratulated upon the usefulness of the tabulated results as published. These, however accurate, cannot be as trustworthy as tests made under actual service conditions, as so much depends upon the nature of subsoil and the effect of atmospheric influences upon same. Whilst excellent results may be obtained with one kind of stone, say upon a chalk foundation, these may be extremely bad if the same material were laid upon yielding clay.

We are now to have tests under everyday traffic conditions, and these upon a reasonably large scale, and from which it is hoped accurate conclusions may be arrived at. The Road Board, in co-operation with several local authorities, is arranging for many different kinds of materials to be laid under identical circumstances supporting the same intensity of traffic. At this moment in the County of Kent, and within ten miles of London Bridge, a length of about 1½ mile of the London–Folkestone Road, has been divided into 23 sections, each representing about 1000 superficial yards, and upon these, materials ranging in price from 1*s.* 9*d* to 9*s.* 3*d.* per yard are being laid.

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The first 4 sections are being put down by the Kent County Council and are respectively :—

Section 1. Ordinary water-bound granite.
„ 2. „ „ „ „ tar painted.
„ 3. Single pitch grouting.
„ 4. Double „ „

these several works being carried out in accordance with the general directions, and specification issued by the Road Board. The remaining 19 sections are given up to contractors who are laying the following :—

Section 5. Durax armouring.
„ 6. Plascom.
„ 7. Cormastik.
„ 8. Kentish Ragstone Tarred Macadam.
„ 9. Slag Tar Macadam (Constable & Hart).
„ 10. „ Double Thickness (Constable & Hart).
„ 11. Tarmac.
„ 12. Roadoleum.
„ 13. Rocmac.
„ 14. Bituminous macadam ("Taroads").
„ 15. Granite grouted with Tarvia (Bristowe).
„ 16. Tarviated macadam (Bristowe).
„ 17. Roadamant.
„ 18. Lithomac.
„ 19. Pitchmac.
„ 20. Natural Asphalte Matrix (Val de Travers).
„ 21. Asphalte macadam (Val de Travers).
„ 22. Trinidad Lake Asphalte, 3 in. thick.
„ 23. „ „ „ 4 in. „

In each section, sockets are fixed on concrete bases, and measuring apparatus has been designed which will fit in these and by which means wear will be capable of measurement to the minutest part of an inch. Periodically, the wear will be measured and carefully plotted upon large scale diagrams.

Very full and complete records will be taken during the entire life of each section, and these will be available to all municipal and county engineers. Traffic statistics will be taken bi-monthly, and reduced to a denominator of tons per

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yard width of surface per annum. Being close to the metropolis, as may be supposed, the traffic upon the section of road selected, is heavy, representing upwards of 150,000 tons per yard width per annum, and including a frequent motor bus service. The standard from which all conclusions will be deduced, will be that of the ordinary water-bound granite surface, and the Author is satisfied that the members of the Institution will cordially approve the general arrangement and will be immensely interested therein.

Members are invited to inspect the work, and if the Author can supply information or figures relating to the several sections, he will gladly do so upon request. Arrangements are now being made for similar experiments to be carried out in other counties, and it is quite conceivable that the information to be derived therefrom may be of more value to the community generally than any or all the monetary grants the Board may from time to time be in a position to confer. Physical tests are also to be undertaken at the National Physical Laboratory, of road stones, pitch, tars, bitumen, etc., etc., and these tests admittedly must be of more interest to engineers than the chemical and fractionation deductions we have been compelled up to the present to rely upon.

Closely allied to and inseparable from the road is that of the bridge question, often now the weak link in a comparatively strong chain. From a national point of view all bridges under roads should be capable of supporting the heaviest load legally allowed upon the roads. For instance a traction engine, empty, may weigh 14 tons, and this when carrying its complement of coal, water, and tools may easily touch 16 tons. A road authority is not required by Parliament to have its bridges sufficiently strong to support such traffic, but may by notice prohibit its passage. Public opinion is, however, generally sufficient to influence County and other Councils to strengthen, but this has no effect upon companies trading for profit, whose canals or railways honeycomb the otherwise continuous highway.

Many anomalous structural conditions have been revealed by detailed inspection of a large number of highway bridges. It has been by no means unusual, for instance, to find that a steel bridge has its main girders of ample cross sectional strength for carrying heavy traffic, whilst its cross girders have proved to be quite inadequate to bear concentrated rolling loads. Such

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conditions show that the bridges have probably been designed by draughtsmen who, in order to save trouble, have based their calculations upon loads per square foot, *dead*, rather than upon rolling loads combined with dead weight, and some few cases have occurred where the reverse condition as to girders has been shown.

The Author recently had an object lesson in dealing with a railway bridge. In 1856 a railway company obtained powers to construct a railway from Sittingbourne to Sheerness, and in connection therewith to construct a bridge—King's Ferry—over the Swale. Plans were deposited with the Board of Trade, and approved by that department, the bridge being constructed strictly in accordance therewith. Although by the defect in the design of its cross girders, the bridge was never theoretically capable of supporting traction engine traffic, yet by the laches of the company's officials, road engines were permitted to cross, with the ultimate result that one fell through into the Swale. As the company was only required to keep the bridge up to the standard existing at the date of its construction (1856), which was in pre-locomotives on highway days, a notice was erected prohibiting all traffic having a load of five tons and upwards upon four wheels. The result of this prohibition was to shut off the Isle of Sheppey from the mainland, so that no agricultural engine for ploughing or threshing purposes could be taken in, nor could a heavy motor car cross.

This appeared to the County Council to constitute a great injustice to the agriculturists in the Island, placing them at a disadvantage with their neighbours on the mainland. Negotiations were, in consequence, opened with the railway company, with the result that an agreement was arrived at, subsequently consolidated by Act of Parliament, by which the County Council contributed in kind between 1400*l.* and 1500*l.* towards the strengthening of the cross girders, so as to enable heavy traffic to get into the Island. This work was accomplished during 1909, and the restrictions imposed are consequently a thing of the past.

The law at present only requires owners of private bridges to maintain them to their original standard of strength. Many are at the moment suffering from the defect of inherent weakness, and it is now quite common to see posted on such bridges notices intimating that the particular one is only equal to —

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tons. Of what use would such bridge be in the event of a national emergency?

An endeavour has been made by the Traction Engine Owners' Association, by that of the Commercial Motor Users, and by County Councils to impress upon the War Department the extreme importance of remedying matters, but as far as I know, with little or no result.

There are certain advocates of an amendment of the law which would compel railway and other companies to strengthen their bridges *pari passu*, with increasing traffic. This is a gospel of perfection which would not be acceptable to any Parliament because it would be unjust to the trading companies.

It should be possible, however, for an inquiry to be held by, say, the Local Government Board, upon the representation of any Government or local authority, or by any body of aggrieved persons, and the Local Government Board should have the power to order that a bridge should be reconstructed in such a manner as to be capable of supporting present-day traffic, with an ample margin for future development, and that the cost of such reconstruction should be borne in such manner as a qualified engineering arbitrator, appointed by the Board, should determine. As the trading company would receive some betterment by the provision of a new bridge in lieu of one which had seen many years of service, a part of the cost should be borne by them, and the balance should be met by charges upon the Imperial and local exchequers as may be decided. As the nation and the local community would benefit by the unrestricted use of the highway, such a division of cost would be amply justified.

The bridge question should be referred to the new Roads Committee of the Institution to whom should be delegated powers to co-operate with interested Associations, so that by united action pressure may be put upon the Government Department responsible to ensure that the Institution's recommendations should be duly considered when fresh legislation upon the subject is contemplated.

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COLLECTION OF DATA FOR STANDARDISATION OF ROAD CONSTRUCTION AND MAINTENANCE.

By D. ELLISON, Assoc.M.Inst.C.E., *Member*,
Deputy Borough Engineer and Surveyor,
West Bromwich.

In some recent papers dealing with the different aspects of road construction and maintenance, stress has been laid upon the importance of collecting data and carrying out experimental research work in a continuous and systematic manner, with the ultimate object of preparing standard specification for road materials, construction, and maintenance. Whilst there may be a considerable difference of opinion as to the value of standard specifications, there is nevertheless a general consensus of opinion amongst road engineers, that reliable, scientific, and thorough investigation is desirable, and would possess great value if the results were tabulated in such a manner as to be readily interpreted.

The Author is fully conscious that much useful data has been collected and statistics prepared after varied experiments by individual engineers, but owing to the lack of some standard form of tests, they have not been strictly comparable or possessed the value they otherwise might have done.

Owing to want of sufficient time, it is not proposed to advance any argument in favour of instituting these inquiries, neither is it proposed to encumber this short paper with a review of the points in need of investigation—they are many and so well known, it is scarcely necessary. Attention might be drawn to the excellent papers recently read before the Institution of Civil Engineers, wherein these matters have been most ably dealt with. The Roads Board have fully recognised the importance of experimental research work, they are now reported to be carrying out, in conjunction with the County Surveyor of Kent, extensive experiments with surfacing materials, and, as is well known, they are doing much in other ways that cannot

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fail to be of great value to Road Authorities. Mention is also made, with pleasure, of the work of our Council, who in appointing Road and other Committees to collect data, and in their recent inquiries relating to wood-block paving, tramways, etc., have given every proof of their sympathy with the proposals.

Without further preliminaries, and starting with the assumption that these investigations are acknowledged as desirable, and should be controlled by some central authority, consideration will now be briefly given to the only points submitted for discussion, viz. ways and means and the authority directing operations, leaving this body to decide the extent of its activities, which must of necessity be governed by financial and other important reasons.

The members of this Institution are responsible for the maintenance and construction of a large proportion of the roads in the country, and the Council, through its members, have excellent opportunities of conducting a very wide range of experiments under greatly varying service conditions, at little or no expense beyond supervision and cost of publishing the results. It is very desirable that they should take a prominent part in initiating and carrying out work of so much importance to its members, and there can be no doubt as to their ready co-operation and the healthy interest that would be created in giving all an opportunity of contributing their quota.

Knowing the increasing demands made upon the time of members of the Council, it is with considerable diffidence any suggestion is made for increasing them, but as there appears to be no alternative, it is proposed the work entailed should devolve upon the Road Committee. This Committee might be given power to add to its number members from outside the Council, and if the work were divided into sections in charge of sub-committees, their labours would be considerably lessened.

It would be a great advantage if this Committee and the Advisory Committee of the Road Board could arrange to carry out investigations conjunctively. In any case, there would be sufficient scope for both without duplicating experiments unnecessarily.

The Committee would in all probability find it essential to call to their aid assistance in carrying out the duties entrusted to them, and expense of so doing, together with the cost of

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publications, would be quite beyond the resources of the Institution, and we must look to other sources. There are several possible ways of obtaining the necessary amount, and the two appealing most strongly to the Author are as given below:—

1st. An appeal might be made to the Road Board for a grant. There is a precedent for this in the grant made by the Government to the Engineering Standards Committee to effect standardisation of British manufacture. The interests involved are sufficiently important.

2nd. An appeal to the various roads authorities throughout the country. A very small sum from each would be sufficient to secure the amount required, and, considering the benefit, little objection to contribute might be anticipated on their part.

It would be strange, however (and would not obtain in any business establishment), if, with an expenditure of about 15,000,000*l.* per annum on road maintenance, arrangements could not be made for obtaining, say, 1000*l.* per annum for the purpose in view. The latter amount is purely conjectural, but no doubt it would be sufficient for a beginning and enable much useful work to be done.

A considerable time would elapse during consideration of procedure and preliminaries as to scope and extent of inquiries, and before funds were available it is suggested that in the meantime information might be sought upon one of the more urgent points—that of road surfacing. It is believed members would willingly respond to an invitation from the Council to make observations and tests of all existing methods and record the results upon lines laid down in a list of instructions framed by the Committee for their guidance. With a careful selection, much data would speedily be obtained, and would prove invaluable for purposes of comparison, and possibly for guidance of the Committee in its future action.

A general description of these tests, with their location, would prove useful in keeping members in touch with any particular method in which they may have a special interest, and enable visits of inspection to be arranged.

The question of cost would, of course, receive careful attention, and if in addition to the actual the cost could also be given in such a manner as to eliminate as far as possible variations due to purely local circumstances, it would be most valuable. A standard rate might possibly be fixed to cover

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the more important of these, such as carriage of material and wages, to be substituted for the actual in arriving at the latter cost. If the standard rate were known, a percentage could be added or deducted, and the result would be made applicable for any district. This method applied to wages would, perhaps, offer some little difficulty, but as it is purely a method of keeping accounts, it might also form a continuation of the Committee's work of systematising.

In conclusion, the Author hopes it may be found practicable for the Council of this Institution to take a leading part in experimental research work. The phenomenal growth of rapid transit locomotion and the advent of an entirely new class of traffic, with its attendant problems and demands, coupled with the great and increasing expenditure, endow the question with great importance, and it is a matter which British Engineers should strive to further to the utmost extent of their opportunities. With a development of our knowledge of the properties of materials, results, undreamt of at the present moment, may be possibly obtained.

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ROAD MAKERS AND ROAD USERS.

By ARTHUR GLADWELL, *Member*, Engineer and Surveyor, Eton Rural District Council.

Road makers are an exceedingly numerous class and their capabilities are legion. Divided into sections, the first, and in point of numbers, by far the least important, are those who really know how to make and maintain a road; the others think they know; and judging by the extent to which they make the whole world welcome to their views on roadmaking they must, indeed, be possessed of an inexhaustible fund of knowledge valuable mostly to themselves, being entirely theoretical, and therefore as plausible as it is unconvincing to those who really do know; but the unanimity with which the theorists join in condemning the serious work of practical men shows that they at least take an interest in the question, and this, in their view, and in theirs alone, qualifies them to be classed as roadmakers.

The serious practical work of the making and maintenance of public highways is being carried out in these days by a relatively small body of men who are, by a whole-hearted devotion to their task, gradually but surely raising the standard both of strength and condition of our roads, and are doing this in face of many difficulties, financial and otherwise. The entire revolution in the user of the road, which has been one of the outstanding features of our advancing civilisation in the past few years, has rendered the task one of stupendous proportions as well as of vital interest not only to the comfort and convenience, but to the welfare of the country.

Many names spring to memory when one pauses to consider who are the men who have given freely of their best in the cause of good roads, and who, purely for the love of the thing, have not merely made good roads themselves but have made others welcome to the added experience they have thus gained, and have in the most unstinted manner made valuable and

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lasting contribution to the general knowledge on the subject in its modern-day phases.

It is, however, not only the men of great skill and opportunities who have added to the store of practical information in this connection; many a man of humble position and restricted opportunities has been and still is working to advance the cause, and doing his little best to meet the demand for better roads. Some receive gratifying public recognition of their work; others not less able or earnest do not, but this neither discourages nor deters them in the work they have set themselves, and it is significant of the earnestness and high sense of duty which actuates the average municipal engineer that few are to be found of them who do not take a more or less real and serious interest in their road work.

This interest is all for good, and must be fostered and encouraged by our Institution by all the means in its power. We are, as an Institution, peculiarly fitted for undertaking this work; it is a position we have a prior right to assume, as being the only really representative body of men who are engaged in highway work, and unless other pretensions are to ultimately prevail we must at once set ourselves seriously and with unremitting energy to the task, and by encouraging our members, one and all, of every class, to take a personal interest in this department of our work, we shall soon prove our undoubted right to lead the profession in this matter.

The road user is not an individual, he is an aggregation of all that is wicked and inconsiderate; no sooner has the careful and much-abused "highwayman" made or repaired a road than the "user" conspires with his fellows to destroy it. None can seriously urge that the average road user is an ordinarily careful person. If he is the owner or driver of a traction engine or heavy motor he is careful only to do those things which will best and soonest ruin the work of the roadmaker, by refusing to break track on the roads he traverses, by overloading, by reckless driving, by stopping to take water at frequent intervals from roadside ponds, and leaving as toll all the clinkers and other muck he can scrape together on the side of the road or on the road itself, and in other ways to leave his trail of damage and dilapidation wherever he goes. He appears to take an especial delight in destroying the edges of footpaths and the verges at the sides of country roads; but his

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chief joy is to come out just after a frost has been succeeded by a thaw, doing damage which costs probably a hundred pounds in good money to make good, while the total value of his load is under fifteen pounds. Apart from the serious public nuisance this class of traffic (as now conducted) has become, the economic question arises, where does the profit or good come in when the damage occasioned to public property so far exceeds the total volume of the goods transported? The law of extraordinary traffic is in serious need of amendment so long as such a condition of things obtains, and it cannot be denied that any form of traction capable of doing such enormous damage to our roads must be inherently defective in design, and requires to be revolutionised. If our road user is a motorist, he is sometimes, but not often, a careful user; but in far too many instances, the man who acquires a motor-car appears to think that "the earth, and all that therein is," has been included in the purchase. He certainly appears to entertain an unshaken belief that the reversion in all the roads of the universe has fallen to him, as tenant in possession in perpetuity. It is useless to consign this class of person to the only appropriate place for him owing to the impossibility which exists of storing petrol in those parts. There is consolation, however, in the fact that he is slowly killing himself off.

Let us be scrupulously fair. It is now contended by the motorist that he is contributing towards the upkeep of the roads; so he is, but at whose cost were the roads first made, and in proportion to user how far short in his proportionate contribution does the motorist come, and will ever remain? He certainly does not pay, nor is he ever likely to be called on to pay, anything like a full and fair proportion of the cost of road maintenance and improvement, and until he does, he should be satisfied with his share of the road, and not attempt to drive everybody else off it, as some do.

In saying this it must not be concluded that the Author is hurling anathema at the whole body of motorists. He is simply protesting in perfect sincerity against the pretensions of a certain section of motorists, whom all know, and is prepared to acknowledge with equal sincerity that others of the fraternity are not only considerate but are essentially fair-minded men, who realise the difficulties of the situation, and who are

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extending the encouragement of their sympathy and support to those who are working for the betterment of our roads.

There are, of course, other road users, which could be enumerated. There are a few horses still remaining, but their decreasing numbers are significant of the changed conditions of road user, while the commercial and manurial value of road scrapings in country districts is steadily declining.

Another class of road user is the pedestrian. In cities and places where people most do congregate he is catered for on the footpaths, but in the country he is occasionally seen emerging from the clouds (of dust) thankful that he is still alive, but regretful that the English language is so deficient in expletives.

In the writing of this paper the Author has, of set purpose, adopted a generalisation, in preference to writing specifically on some definite phase of the question. If any specific view were required of him in this connection he would say that if the Road User will only find the money, the Road Maker will spend it for him, judiciously, intelligently, with ever-increasing skill, and withal economically.

DISCUSSION.

MR. J. PARKER: I have been lately making experiments in road making, some successful, others have been failures. I find that it is not so much the motor car as the heavier mechanically propelled vehicles which cause the damage to the roads. They come upon the roads immediately after frost, breaking up the surface, and when the roads have inadequate foundations the next traction engine which passes along cuts into the surface of the roads, skewing the material out of the centre into the side of the roads, or breaking right through it. We are faced with the difficulty of getting sufficient money from our local authorities. They look upon immediate expenditure with considerable alarm. I have found that improving a road, and spending a rather considerable sum at the outset is real economy in the end. For instance, I have recently experimented with a road in which the expense of Tarmac over and above ordinary macadam only came to an additional 5*d.* per square yard, the difference between the two materials was as between

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1*s.* 10*d.* and 1*s.* 5*d.* per square yard. We were near to a good stone—a basalt—and 1*s.* 10*d.* may be regarded as a very low price indeed. For that reason local considerations must guide us. As motor cars and steam-propelled vehicles of a heavy character are here, and have all come to stay, it is the province of the surveyor to make roads so as to carry the traffic. I cannot go to the depth of foundation recorded by Mr. Maybury in his paper. I have to study economy, and if I get a water-tight surface road, bound with tar, it is the best I could do. Tar is the only material which I have found economical and suitable for this purpose. Hereford, which has less than 50,000 inhabitants, is not in the position of county boroughs. I have 16 miles of main roads to be paid for by the county council. Mr. Jack, the County Surveyor of Herefordshire, has said in his report that the expenditure of 5*d.* per yard on tarring the macadam has had the effect of doubling the life of the road. If you multiplied that by 3000 yards it means a saving of 140*l.* or 150*l.* The moment we get our respective councils to see that there is real economy by using Tarmac instead of ordinary macadam, they will come to the spending of extra money. I move a vote of thanks to the Authors of the papers.

Mr. W. Nisbet Blair: May I second the vote of thanks to the Authors of the papers? Mr. Parker has mentioned prices which our members appreciate do not apply everywhere; but there are many visitors present who may absorb those prices, and grasp eagerly at that additional 5*d.* per square yard by which they are going to get a double life for their roads. We can make a complete recoating of a macadam road for a varying price from 1*s.* 6*d.* to 2*s.* per yard. That may differ from Mr. Parker's price, because of the difference in the cost of material to him and to us. Tar grouting is a very big item in my district. It costs us 3*s.* 2*d.* or 3*s.* 3*d.* per load to get rid of the old material to begin with. I can speak quite positively as to that, because we have had tenders giving those results when preparing an old road for tar macadam. But having done that and surfaced up, and rolled the foundations, it then costs us 3*s.* 5*d.* or 3*s.* 6*d.* per yard to put 4 inches of tar macadam on the road. That is a very different tale to what Mr. Parker has told us. We derive an immense advantage from a tar-bound road as compared with the old water-bound road. There are advantages to which we cannot attach a money value. The householder is not

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smothered with dust as he otherwise would be. The advantage to the horse owner of a tar macadam road is a very material one, though he could not put a money value upon it. And the silence to the householder, where there is heavy traffic, is another advantage. There are many varieties of this kind of paving. There are tarred slags, tarred granite, and ordinary macadam grouted with bitumen, which gives you another result. I have made experiments with these materials, and the results have come out in a manner very instructive, though disappointing. I will mention first of all a very successful experiment on a piece of road which is known to everybody who comes to London, the approach road up to Euston station. It had to be coated every year at a cost approximately of 2*s.* per yard. Last year we reformed the road, taking off it as much as 9 inches. We coated it with 4 inches of macadam, and it was grouted with a prepared bitumen. There have been no repairs upon that road since construction about ten months ago, except two water trenches to repair leakages. Its condition is very nearly perfect, though not absolutely. There are a few places where the surface seems to have been picked up by the traffic, and apparent looseness in the material which remains; but they are quite limited in number, and would not cost more than 10*s.* to repair. That road cost for grouting, making, and material 5*s.* per yard, and even at that price it will prove economical. The traffic over that road is something like six hundred and fifty vehicles an hour. They are nearly all rubber-tyred vehicles. Another road, which carries two hundred and thirty vehicles per hour, the great majority with iron tyres, made at the same time and at the same cost, with Guernsey granite, of 2-inch gauge, grouted with prepared bitumen, proved a failure. Every stone has seemed to work loose, although the same conditions which tended to success applied in one case as the other, yet the result is entirely different. I attribute it to the difference of traffic, the iron tyres in place of the rubber tyres. With the iron tyre you have an absolute blow expended by the wheel upon the stones instead of the cushioned rolling contact of a rubber tyre. Therefore with the rubber tyre you get a much distributed effect upon the macadam. In the same road where the failure occurred we tried two other materials. One was a prepared tarred granite. It contained a proportion of granite chippings to fill the cavities, and leave no vacant spaces in the material. That was

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consolidated as well as it could be, and grouted with bitumen. That has not absolutely gone to pieces as the grouted macadam has; but it is not by any means a success. The third section of the road was laid with another patent form of road construction. A patent fluid is applied to limestone chippings and dust which are spread in the form of a mortar on the foundation of the road, then the ordinary macadam is spread on that, the idea being that by rolling you work the mortar upwards, and it is completed when the mortar has worked through to the surface. It did not at first consolidate, and had all the appearance of failure until about a month ago. Then the road began to set, and now after ten months that section is the best of the three, with this disadvantage, that its surface is worn in slight hollows, and vehicles passing over it bump a little. Now as to Mr. Maybury's paper. We all know his reputation in road working, and we look forward to the experiment which he is going to make for the Road Board with a good deal of interest. There is an expression in the paper which I do not understand, but coming from Mr. Maybury we must give it weight because he is a member of the advisory committee of the Road Board. Mr. Maybury says, "The Road Board policy and their conditions have been much criticised, many Councils desiring to have a sum of money handed over in direct relief of rates, overlooking the fact that, however willing it may be, the Board is debarred by statute from making any such contributions." That is a statement I do not understand. The Road Board derives its revenue from the motor duty and the petrol tax. Supposing it is proposed to substitute a tar-bound road for a water-bound road, and a grant is made for that, surely it is in direct relief of rates. I cannot conceive a contribution made by the Road Board which is not for the relief of rates, because if the work has to be done then its cost must come out of the rates. Then I should like to ask how is the Road Board debarred by statute from making such a contribution.

MR. J. RUSH DIXON: It is in particular reference to the paper of Mr. Maybury, and the experiments which are taking place on the edge of the borough which I have the honour to serve, that I desire to speak. Only last Tuesday I went over the road where these twenty-three experimental lengths have been laid. If any one, who thinks those lengths of different material are too short, would take the trouble to see this road

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from end to end, he would probably afterwards agree that it is well chosen; it is practically level, is on a main London road, taking a tremendous amount of traffic of all descriptions, motor traction and all other kinds, and is particularly free from those interfering by and cross roads. Although perhaps in some cases a length of 100 yards may be too short for the experiment, yet I think we shall be able to glean from these information which will be of great value to our various authorities. Some of these experimental lengths are not completed yet, but I took particular note of those in hand, and I was provided with a chart showing the position of the different materials. The only thing that was wanting on that chart to my mind was the nature and name of the materials which were being used. It seemed to me that basalt and slag were being used to a large extent, and I formed the opinion that if the same experiments had been carried out with Guernsey granite, quartzite, and other materials, it would have formed a useful guide in arriving at an idea as to what are really the best materials for country roads taking that traffic. I agree with what Mr. Blair has said as to the fallacy of comparing the cost of making and maintaining roads in one district with that of another district. In Hereford, Mr. Parker says that tarmac only costs 5*d*. per yard more than the ordinary water-bound macadam. In London generally, and in Woolwich, such comparison is altogether misleading. The chairman of my Highways Committee (Alderman Syer) is here present, and fortunately for me he knows sufficient of the matter to realise that tarmac cannot be laid in Woolwich for the additional 5*d*. per super yard over water-bound macadam. Not only does team labour cost more, but the workmen's wages are fifty per cent. more than in Mr. Parker's part of the country. Mr. Maybury makes one or two remarks in his paper which to my mind are well worth consideration. He says, "The intensity of the wear upon our highways is likely to be more severe as the use of the motor becomes more general." I have had a good opportunity of seeing the effect of motor traffic on roads from London to the south coast, and I have formed the opinion that motors with rubber-tyred wheels are just as destructive as those with iron tyres. Then he says in the south of England, where the demand for tar has been the greatest for road treatment, the purchaser is being most severely penalised. Whereas I used to have to pay 2½*d*. to 2¾*d*. per gallon for the tar which I used for some

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twenty thousand square yards of tar painting, I am now having to pay a penny per gallon more for nearly double the quantity used. It seems to be unfair that those who have made the demand for the tar should be penalised to this extent, and it is to be hoped that some such protest as is contained in Mr. Maybury's paper will have its influence on the tar producers. As he says, there is no superiority in the tar produced in the south of England over that elsewhere, it is only a penalty for having made it useful. I had very great difficulty in inducing my Council to go in largely for tar painting, and I am therefore glad to hear Mr. Maybury endorse what I have already said to my Committee, that there is no question as to the efficacy of tar painting.

MR. S. HUTTON: I think Mr. Gladwell ought to have added to the road-maker and the road-user the road-destroyer—the Gas Company, the Electric Light Company, and so on. I think more damage is done by trenches than even by traffic. There is one point raised by Mr. Dixon as to the recent rise in the price of tar because the surveyors have made a use for it on the roads. From the commercial point of view you cannot blame the Gas Companies for making the best price they can for the tar. In my town I make a corner in tar by arranging to take the supply from January to September. I get a very good road metal from the manacles, delivered in Exmouth for 8*s.* a ton, so I can put a decent coat on the road for 8*d.* or 9*d.* per yard super. We bind it with a fine gravel, and when we are finishing I dust it over with dry cement; then I throw some grit from the beach on the surface. I find, on brushing off the grit in about a fortnight's time, I get a perfect road. It is quite impossible for us to reconstruct the foundations of the roads. I think the best thing is to put a good material on the top.

MR. E. PURNELL HOOLEY: I do most earnestly protest that it is wrong to start a comparison of country roads and districts with what is being done in the neighbourhood of London. We should be considered mad if we suggested the spending of 5*s.* per yard super on road surfaces, and if we can get an equally good result for the traffic with which we have to deal for 1*s.* per yard, why *should* we spend it? I am more than interested in the experiments that Mr. Maybury has been good enough to undertake in Kent. But there I do not think Mr. Maybury would condemn any material which does not stand as well as a more

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highly priced material, which has four hundred vehicles an hour passing over it, and say it cannot be used anywhere. I was interested in Mr. Hutton's remark about stone at 8*s.* per ton and roads which worked out at 8*d.* per yard. If I could get granite at 8*s.* per ton, and my roads to stand traffic and work out at 8*d.* per yard, I should be pleased to do it. I would be much more interested if Mr. Hutton would give us the cost at which his roads come out altogether. I would urge you to go back and not slavishly follow the example of any district. I ask you to consider the condition of English roads to-day. There is hardly an inch of foundation anywhere. In the whole county of Nottinghamshire there are just the foundations which have been put in in the last few years. If you had to start and put in foundations on the roads in the rural districts, that is, put in the necessary 6 inches of foundation plus the top material, you are going to such an expense that no Council would keep you. If you can put three or four inches of material on the top of your present surface and get as good a result, you would still be considered a fool if you put in expensive foundations as well. I do not think it is a benefit to any road to have a lot too much material on it. We have had a cost of 400*l.* a mile thrown at us in counties which are really paved streets. Then we have to consider whether our Councils will give us 75*l.* a mile. If you think you are going to get as good results for 75*l.* a mile as from 400*l.* a mile you must be a long way out from comparable figures. Directly a rural man loses his head and says, "I have got to reform my roads, and raise them to the standard of a town district," the better it will be for him to leave the country and go to a town district. I know my Council would have told me to clear out years ago if I had put up the cost of my roads 10*l.* a mile. I am very keen on trying to find out the best results for the least expense. How can you have standardisation of roads? You take the traffic on a road in West Bromwich, unless you have gone into the past history of that road, it is not comparable with a road in the county of Nottingham. I have to thank Mr. Maybury for the kindly reference to myself. I know I am old-fashioned in many of my ideas, but I know the word revered begins to sound a little ancient.

Mr. W. Nisbet Blair: I described the process as consisting of a separate layer of mortar made of limestone chippings, which

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is mixed with a patent fluid, and then you lay the macadam on the top, using the ordinary 2-inch Guernsey macadam.

MR. G. W. LACEY: There is just one point I should like to ask Mr. Maybury. If he would kindly say, with regard to his Kentish ragstone tar-macadam, the gauge of the metal he is using. It is not stated in the paper. Mr. Maybury says that after completion it is surface painted and dressed with fine grit or chippings. Is it not a better plan to cover with a very light coat of fine tarred material to fill up the interstices instead of painting over with tar an already tarred stone? I should like to say that tarred granite depends a good deal upon the class of granite and how it takes the tar, but chiefly on the quality of the tar preparation. Mr. Bull, county surveyor of Cheshire, has been laying down a large quantity of tar-macadam from a quarry in North Wales. I have put some down myself, and it goes together very well; it is a granite which takes the tar admirably. It has met with success in Cheshire, and on some of the roads in Shropshire where it has been tried it is wearing well.

MR. H. A. GARRETT: We in the West of England are told we know nothing about road-making, yet I say we have some of the best roads in the country. I must thank Mr. Maybury also for his very refreshing speech. I came up to learn all about road-making, and I am very glad to hear what Mr. Hooley has said about the work we have to do. I am glad also to find Mr. Maybury says we have to cut our garment according to our cloth. You have to deal with the materials in your own immediate district, and immediately you bring in proprietary articles you are tackled by the ratepayers, who want to keep down the rates. The point I want to raise arises out of Mr. Blair's remarks. He has referred to three samples of road-making, one in which limestone chippings were used for grouting and foundation before the top material was put on. I want to know whether that turned out to be the best. I come from a limestone district, and we are told that limestone is a thing of the past for road-making. I am opposed to that view if the road is properly made. The district I come from has several miles of hill and valley roads varying in gradient from one in three to one in fifteen. It is generally a district of a very hilly nature, and, in tar-painting the roads, you have got to remember that you have still horses with you, and, though you have to legislate for the future and the motor, you have still also to legislate

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for the traffic you have with you to-day. From my experience it is difficult to lay tar-macadam on these steep gradients, owing to the danger to horse traffic.

MR. NORMAN SCORGIE: There are just one or two points in respect of Mr. Maybury's paper on which probably he may be able to give us some further information. Mr. Maybury says, "In the present financial year the Author has estimated for the use of 32,000 tons made of Kentish ragstone," but when we come to the experimental lengths of road, Mr. Maybury seems to have abandoned this material, and does not in his experimental work use it. I do not know whether it is want of confidence in Kentish ragstone.

MR. MAYBURY: One of the experimental lengths is being laid with Kentish rag macadam.

MR. SCORGIE: It is not being used by the Kent County Council. I do not see how you can complain of the Gas Companies putting up the price of tar. They are business people. If the demand warrants the increase of price, they are justified in charging it, however much it may be to our disadvantage. If we were in commercial life, I have no doubt we would do the same thing. The policy of the Road Board is mentioned, and we are told the Road Board are not prepared to give any contribution for the direct relief of rates. They are prepared to give you a grant in carrying out improvements, but if you are only going to spend a certain sum of money, and want a grant from the Road Board, they will not give it you, because it would go to the immediate relief of rates. Mr. Hooley has referred to his many experiments, and the policy of making experiments. I agree with him entirely, and I think engineers are at a great disadvantage on account of either annual or triennial elections. Although we may be able to persuade our Councils that it is an economy to carry out works by an improved method, each member of the Council is thinking not of the future but of the present, and what the local chancellor of the exchequer's estimates will be, probably within a few months of his having to appeal to the ratepayers. He only considers the moment, not the future, and goes on the old adage, "Why should I do anything for posterity?—posterity has never done anything for me." As to standardisation, that is an ideal, but the results may be very erroneous. While one is very desirous of having standardisation, the results would be misleading, particularly in

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small places where they have little traffic. Take Mr. Parker's remarks as to macadam. It is some time since I was at Hereford, but at that time there was little traffic on the roads, and the people did not seem to wake up until noon.

Mr. Stubbs: I have had some little experience with tarred granite macadam. Some two years ago I put down a fair length of tarred granite *in situ*. It has been in use for two years, and is as good to-day as the day it was put down. The traffic on that road is about as heavy as anything I know. In Blackburn we are makers of large, heavy boilers, over three hundred being sent out by one firm per year, and many go over this road. Then I put down a length of "rocmac." Those two lengths of road are equally good; I do not know which is going to last the longer. I can say, as to rocmac, it is cheaper and better to put down than the tarred granite. In Lancashire we have not so much sunshine, and I was some seven weeks in getting the asphalte work completed owing to rain. That somewhat increased the cost. The tar macadam was about 10*d.* per yard, and rocmac about 7*d.* per yard above the cost of water-bound macadam. I am thoroughly satisfied with both systems, and the Committee are too. We have determined that in future we shall use either tarred granite or similar material. In a working town most of the streets are paved, but all the residential districts are macadam. As far as the macadam is concerned, we are going in for a considerable quantity of tar-spraying. The main road runs from Blackburn to Preston Docks, and a large amount of timber and other heavy material is carried by motor-waggons along this road. For the last three years I have proved, by using Tarvia for the road, it has extended the life of the macadam by something like two years.

Mr. A. J. Price: Some years ago at Liverpool I mentioned that you could make a good tar macadam road of granite. There were some Members who disputed that fact. I was able to say that at Lytham I had a granite tar macadam road which had been laid seventeen years, and nothing had been done to it. It has now been down twenty years, and nothing has been done to it since it was first laid. I have other roads which have been laid seven or eight years, and I am open to invite anybody to come and see them and tell me if they can show me any better roads of tarred limestone. There is one point as to the measuring of the wear of a road of tar macadam by the instrument

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Mr. Maybury has described. It seems to me you will have to be very careful in measuring tar macadam. When you are laying tar macadam in a road against a manhole cover you have to lay the tar macadam for half an inch to an inch higher than the cover, according to the thickness of your asphalte. That inch is not going to wear away, but it will in a short time compress to the same level as the cover. Tar macadam compresses more than any other material. The ordinary water-bound macadam will not shrink in the same way, or a stone sett, or a wood-paved road, and you will have to bear that in mind when considering the wear of a tar-paved road.

MR. E. Y. HARRISON: I think we all owe a debt to Mr. Maybury for arranging for these various tests. If any authority should arrange for tests of this character it is such an authority as the Kent County Council. I am sure surveyors will watch them with interest, and I hope we shall have full particulars of the results. The question has been raised in Mr. Maybury's paper as to tar and the price of tar. Of course we can expect that the price will go up; but the warning will now go forth to tar distillers that unless they provide for the distillation of the tar at a reasonable price we may have to supersede same in favour of the proprietary articles on the market. I have been able to lay down some tarred granite macadam; I have added to the tar, pitch and resin, and the result is very satisfactory indeed. I have also used ordinary tar as grout to granite macadam, and obtained very good results. With regard to tarred slag macadam it may interest some members to know that we have been spending 2000*l.* to 3000*l.* per annum on tarred slag macadam. We have obtained the slag at 4*s.* 6*d.* per ton at the works in our immediate neighbourhood, and the carting does not cost us more than 6*d.* per ton, so we get the slag at 5*s.* We have laid some thousands of square yards at a cost of 1*s.* 3*d.* per square yard laid 3 inches thick. That compares with the ordinary water-bound granite at 1*s.* 6*d.* per square yard. It therefore pays my Council to lay down tarred slag macadam, which has twice the life of water-bound granite on secondary roads. Very little granite is now being used except on main roads. That 1*s.* 3*d.* per yard includes the material, laying, and rolling of the road. We hire an 8-ton roller at 1*l.* per day. The road is finished with ¼-inch granite chippings. Previously slag chippings were used as finishing material, but we find the granite

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chippings make all the difference as to slipperiness. I never have any complaints of slipperiness now. Many of our roads are very low indeed in relation to kerb. The arrangement has been in the past, I do not think it is quite legal, for the Council to take over a number of roads before they were built upon on the consideration of a certain amount of money being deposited with the Council for the last coat of metalling. Well, the Council spent that money, and the road never received the last coat, with the result that all I have got to do now is to shape it up, and finish with 3 inches of tarred slag macadam. We feel rather a grievance against the Road Board for only granting sums of money for surface tarring, because many roads require reconstruction, and the Road Board might see their way to contribute towards same. I cannot agree with Mr. Gladwell as to road users. Increased traffic means increased prosperity, and we should not grumble very much because the cost of road maintenance is increasing. The public use the roads, but they also pay for their maintenance.

Mr. T. Frank: After the remarks respecting the city of Hereford made by one of the previous speakers it is with diffidence that I venture to speak. For although representing a so-called "sleepy cathedral city," yet we have up to as many as ten thousand people passing through the city in a single day, and in one respect at least we are not in the fortunate position of some of the larger municipal authorities who have tramway companies to maintain a portion of the roads over which the people travel. The railway company run many of these visitors over the roads in large and heavy motor 'buses, and though running a regular service throughout the year, no special contribution is made for road maintenance. On a rather narrow road which connects Leeds and Harrogate with the north, a length of "rocmac" with 2-inch whinstone has been laid, and it is standing the traffic splendidly. In another wider part of the same road a somewhat similar type of construction has been adopted, but it has not been quite so successful. In reference to the tarpainting of roads, it is not often that we have gas companies who prepare their tar so as to meet the surveyors' requirements, and I suggest that we should treat the material ourselves. For some years I have bought crude tar, and refined it by passing steam through coils of pipes placed near the bottom of the tar holder. The results obtained have been eminently satisfactory, and samples sent for

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analysis proved that in addition to the loss of water a considerable refinement had been obtained, and I believe that this process has since been copied by the Harrogate Gas Company. The whole cost of buying, and thus treating crude tar, only amounts to about one half the cost of chemically refined tar, and I can complete the tar-painting and sanding, etc., of roads for under $\frac{7}{8}d.$ per square yard.

MR. H. P. MAYBURY, in reply, said: I am entirely in agreement with Mr. Hooley when he says that nothing like 5*s.* per yard can be entertained for a moment as expenditure upon country roads. To save unnecessary discussion I will at once deal with the experimental sections of road at Sidcup, and the reasons for laying same. It is common ground that from time to time traders come to most of us and tell us if we will only use their particular material upon an experimental length, we should never use anything else. Since the creation of the Road Board, these traders have, very properly, approached the Board and have asked to be allowed to show what their respective materials can withstand in the way of traffic, complaining that often, owing to prejudice of the municipal and county engineer, they had not had a fair field in the past. The Board, being anxious that the value of all road materials should be tested, decided to arrange for the tests to be made under identical service conditions. As the members know, the price of the respective materials laid down at Sidcup varies from 9*s.* 3d. per super yard to 1*s.* 6*d.* for ordinary water-bound granite macadam. Whilst 9*s.* 3*d.* a yard is an impossible figure for material for use upon ordinary country roads, it is conceivable that it might be extremely serviceable and of good value for laying upon main roads in important boroughs and urban districts. If this be so, then the county surveyor is interested, just as much as the borough or urban man, because all are desirous alike of obtaining the best value for the money expended. It may be that some of the higher-priced sections will prove to be the cheapest. The standard from which all measurements will be taken is the ordinary water-bound road. Thus No. 1 section is so constructed, and is not treated in any way save that it has a dressing of calcium chloride in order to keep down the dust. At two places in each section measuring boxes are fixed, and arrangements are made for monthly records to be taken showing the wear, and these measurements are carefully recorded and plotted. This procedure

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has been adopted by Mr. Brodie at Liverpool with excellent results, and I feel sure that when the information so derived is available for the members of this Institution, the unanimous opinion will be that much useful information has been removed from the speculative and hypothetical stage. I thank you very much indeed for the vote of thanks you have so very kindly passed to me, and I feel that you have been extremely kind in your criticisms of the paper which I have had the honour of submitting to the institution. In a weak moment I promised Mr. Greatorex that I would write such a paper, and although subsequently I endeavoured, under the excuse of pressure of work, to get out of my promise, he would not let me do so. Mr. Blair raises a pertinent question as to the monies granted by the Road Board, and which, I said, are not given in relief of rates. Mr. Blair considers such a statement an inconsistency, being of opinion that any money given to an authority *ipso facto* becomes a grant in relief of rates. In kind I agree it does, because all money spent properly may be assumed to benefit the district in which it is so expended. As a matter of fact, however, the Road Board may not contribute any sum towards maintenance. The grants must in every case be made towards improvement as distinguished from maintenance. The Board, in making the grants, have imposed conditions which have not been taken kindly by some County Councils, these latter being of opinion that certain sums should be handed to them from the Treasury fund to expend in any way they may think proper, upon the main roads of their county. From the improvements carried out with Road Board assistance, probably maintenance indirectly benefits, but at least twenty-five per cent. of the cost of such improvement must be provided by the authority taking the grant. It will be agreed by this Institution that this policy is a sound one. A test, which the County Councils themselves often apply to the urban authorities, when dealing with works of improvement on main roads, is to inquire how much the authority itself is prepared to find towards the cost. These same Councils are now finding fault with the Road Board for adopting procedure which they themselves instituted and which they have fairly used for some years. The Board is being much criticised by county authorities, and, in my opinion, unjustly so. At all events, it deserves all the friendliness which this Institution can give it, because, for the first time in

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the history of a Government department, the engineer and surveyor is recognised, as distinguished from the clerk to the authority. It will be within the recollection of all county surveyors that the Board suggested they should convene meetings of all surveyors in their particular counties and should discuss with them the schemes to be submitted to the Board. Again, the chairman of the committee and the *surveyor* are invited to see the Board. Hitherto it has always been the chairman and the clerk of the council. If for no other reason than the recognition which the Road Board has given to our profession, I claim that for this it should receive the greatest possible assistance at our hands. Mr. Rush Dixon referred to what he described as the large quantity of basalt which had been used in connection with the Sidcup experiments, and thought it would have been much more instructive if certain granites had been used as well. I am afraid Mr. Dixon at the time of his inspections did not look very carefully or he would have observed that many kinds of roadstones were being used. Take No. 5 section, for instance —durax. Half of this is laid with Guernsey granite setts and and the other half with Leicester. The Plascom section is laid with Guernsey granite. No. 12 is laid with Penmaenmawr, whilst No. 13 is Penlee. No. 14 is Guernsey, whilst Nos. 15 and 16 are Penmaenmawr and Clee Hill respectively. No. 19, again, is laid with Guernsey granite, as is also No. 22. Then we have several sections laid with tarred macadam, the aggregate of which is blast-furnace slag, so that one would suppose that there was sufficient variety to satisfy the most exacting appetite. In all these matters we allowed the contractors to say what they preferred to use. My friend Mr. Scorgie chaffs me for not using Kentish ragstone. He must surely have overlooked the fact that section No. 8 is laid with this material by one of the contractors, who is supplying my Council with a large proportion of the 32,000 tons of the same stone which we are buying in the present year for use upon the county roads, and is acting as the representative of his colleagues in the trade. The contractor is laying the material himself, being of opinion that he can do it better than I can, and I was particularly anxious that he should have a try. It has always been understood that at stated intervals an authoritative report would be issued, under the auspices of the Road Board, and which report would be available to the members of this Institution. A question has been raised

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as to the cost of tar-macadam in the south of England. This is so obviously governed by the freightage which is upon the material that it is quite impossible to endeavour to make any comparisons of cost without knowing all the factors which go to make this up. As to the cost of tar, we in the south of England have a grievance against the gas engineers, and I say this advisedly. For many years, when I was in the Midlands I had the honour of being a member of the Midland Association of Gas Managers, at which time I was directly interested in the manufacture of gas. I have continued to keep up my connection with the Institution of Gas Engineers (of which I am a member), and in all sympathy I would say to the gas engineers of the country that they are not considering their best interests in imposing the last farthing upon those who are creating the market for their tar. In the south of England four years ago the late Sir George Livesey sent for me and said, "You may have as much tar as you want for the treatment of roads at a penny per gallon." I took him at his word, and bought in large quantities. To-day I am asked threepence per gallon for the same material. That I am not alone in this respect is proved by the fact that Mr. Angell, of Beckenham, says that a year or two ago he could obtain tar at a penny per gallon, whilst to-day he is being charged at the rate of threepence or threepence-halfpenny. It is possible now to buy tar in the Midlands and pay long carriage upon it and still get it to the point of user at a price which compares favourably with that sought to be charged by the London companies. During the present year I have been the means of purchasing about one million gallons, and as other neighbouring counties are using large quantities, it follows that we have sensibly improved the position of the gas companies, and now we are being penalised for having done so. I warn gas makers that we shall probably leave them and go in for bitumens or asphaltes. Whilst the latter may be more costly at first, it will be agreed all round that we may reasonably expect more efficiency from its use than from tar, and, if we once leave the gasworks, in all probability we shall never return. Now as to the efficiency of tar-painting. That the use of tar does materially prolong the life of ordinary granite roads cannot now be gainsaid. Primarily it was undertaken for the abatement of dust, and, whilst it still continues to do this most effectively, we are satisfied that maintenance benefits. In the retaining

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urban districts in my county at the outset we paid half the cost. Then we paid three-quarters, and now the whole cost, so long as the latter does not exceed a penny per yard in one account year, and urban surveyors in the county will bear me out that I do all I can to encourage its use upon every main road in the urban districts. Mr. Hutton stated that he had been able practically to corner the tar which was produced in his particular neighbourhood. Perhaps he will kindly tell us what he pays for the monopoly. Mr. Lacey, of Oswestry, referred to the laying of tarred Kentish ragstone macadam, and suggested putting on a fine tarred material as a sealing surface. I may inform him that the aggregate composing our ragstone tarred macadam is from 1½-inch to 2¼-inch cube, this being laid in one coat, and before it is quite consolidated the surface is sprinkled over with a fine material of about ¾-inch gauge, in order that the interstices should be filled up. The two coats are then rolled down together. After rolling, we leave the surface for two or three weeks, and then tar paint, gritting with granite chippings. We find it good policy to tar the surface before the tar which is upon the ragstone is worn off by the action of the wheels. This procedure to some may appear rather extravagant, but in practice it really is not so. Mr. Grieves referred to the Road Board's requirements in relation to the county of Surrey, stating that he was under the impression that the Board had laid down a hard and fast rule as to what material should be used as the aggregate for tar-macadam to be laid in that county. I can assure Mr. Grieves that this is not the case. The Board practically accepted Mr. Dryland's suggestions. Mr. Stubbs referred to tar-macadam laid on a principle which is very much like pitch grouting. That procedure is not tar-macadam as generally understood, although the results may be very much the same. It is no novelty, I think, to find that tar-macadam is being made with all sorts of stones used as the aggregate. Clee Hill are now supplying their material so prepared, as are also Penmaenmawr and several of the Scotch granite quarries. Mr. Price, dealing with the experimental sections, raised the important question as to what allowance would be made for contraction and consolidation by the traffic after the works should have been completed. This has been carefully thought out, and the contractors have been asked to state the period, when consolidation would have terminated. In the opinion of some it is six

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months, whilst others say three months. Mr. Harpur has kindly suggested that I should read a further paper to the Institution, giving the results of these experiments. Whilst it is always a pleasure to meet Mr. Harpur's wishes, I can assure him that such a paper will be quite unnecessary, because the Road Board will issue a report upon the subject which will be available to every member of this Institution. Whilst it is not expected that these, or any other experiments will give conclusive results, still it is reasonable to hope that, with a known traffic and under identical conditions, we shall be able to arrive at a practical conclusion, which we can never hope to obtain from traders who have material to sell. I was much interested to hear from Mr. Frank of his contrivance for driving off the ammoniacal liquor from the tar and which he claims has the effect of freeing or dehydrating it. I do not think Mr. Frank will be well advised in patenting this steam coil, because a similar arrangement has been in use for an identical purpose for many years. Unless you work with superheated steam, and keep the tar in contact with the heated coil for a considerable time, I fear it will be found impossible to get the water contents down to say 1 per cent. which is the standard that the manufacturers of the dehydrating plants are now aiming at. I am quite sure it will pay every gas and municipal engineer to make an arrangement for dehydrating the tar at the point of production, viz. the gasworks, rather than that the tar should be sent from the gasworks to the distillery and back again, probably to the same district, after dehydration has been effected. This latter course means that the user pays two railway freights, which he can well avoid and which would more than justify a higher price being paid to the gas engineer to repay an outlay incurred upon a dehydrating plant. I have been fortunate enough to make arrangements at some of the gasworks in the county of Kent, where these plants are now in evidence, and where I am paying about three farthings a gallon more for the dehydrated tar than was originally charged for the crude article.

MR. A. GLADWELL, in reply, said: Fortunately for myself I have escaped any severe or detailed criticism in connection with my paper. I am afraid one of the reasons why I formulated my papers in the terms I did was to escape such criticism. I was rather struck by one remark of Mr. Parker of Hereford. He was speaking of the various classes of local authorities, and I should

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say for the first time in history he placed the Rural District Councils first. I have always been accustomed to having Rural District Councils and surveyors named after every one else has had a show. But I have always flattered myself with the reflection that if ever you view a State procession you see the most important persons come last. Mr. Parker also made a remark about the water-tight surface of roads; it has long been my view that the water-tight surface of a road virtually increases the value of the foundation. Mr. Blair has referred to the distribution of road grants. I should like to call attention to the text of the Roads Improvement Act, which states that the Road Board are empowered, with the consent of the Treasury, to make grants to all highway authorities. Yet the Road Board, in the circular they have issued, give it out that they are prepared to give the most favourable consideration to such applications as are made with the consent and support of County Councils. I say without hesitation, and I have held that view ever since I read it, that circular is absolutely and clearly wrong and inconsistent with the spirit of the Act of Parliament.

MR. ELLISON: I thank you for the vote of thanks you have passed to me.

On Wednesday the Members were the guests of the Mayor of West Bromwich at a luncheon in the Town Hall.

On Thursday they were entertained by the President, and the Members of the West Bromwich Council to luncheon in the Town Hall. In the evening the Annual Institution dinner was held in the Town Hall, the President (Mr. A. D. Greatorex) in the chair.

Friday was devoted to a round of visits to various Municipal Engineering Works in the town and adjacent district. The Members visited the Oldbury sewage disposal works. In the afternoon the Members were entertained to tea by the President at his residence.

On Saturday a visit was made to the works of Messrs. Hickman, Ltd., at Wolverhampton, and the works of the Tarmac Company. Col. Hickman entertained the Members to luncheon in a marquee.

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MIDLAND DISTRICT MEETING.

July 29, 1911.

Held at Handsworth.

A. D. GREATOREX, PRESIDENT, *in the Chair.*

THE members assembled at the Council House, Handsworth, where they were received and welcomed by Councillor T. H. Berry, J.P., Chairman of the Urban District Council.

The President, on behalf of the members of the Institution, thanked the Chairman of the Council for the kind way in which he had welcomed them to Handsworth.

Mr. H. Richardson was unanimously re-elected Honorary Secretary for the Midland District.

HANDSWORTH: A FEW HURRIED NOTES.

BY H. RICHARDSON, ASSOC.M.INST.C.E., *Member*,
SURVEYOR TO THE
URBAN DISTRICT COUNCIL OF HANDSWORTH.

THIS meeting may appear somewhat in the nature of an anti-climax after the very successful Annual Meeting held at West Bromwich less than a month ago, but Handsworth being thought a convenient centre, where a sufficient number of members might be got together, in order to pass the resolutions confirming the alterations in the Constitution of the Institution, a District Meeting was hurriedly arranged.

There is so much of historic interest to the engineer in Handsworth, that one's greatest difficulty is to know what to omit when arranging a programme to fit so short a day. Although the history of Handsworth during the last thousand

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years is very interesting to the antiquarian, the work in the latter half of the eighteenth century of the great engineers, Watt, Boulton, and Murdock, would be more interesting to the civil engineer; but probably of equal interest to the municipal engineer will be the last score of years, in that it has seen a rural suburb rapidly changed into a town of 70,000 inhabitants, some of the years seeing a thousand new houses occupied. It will readily be imagined that the local authority has been kept active by the rapid growth of the district. The Author has endeavoured to avoid hampering the meeting with descriptions or inspections of works which, although excellent in themselves, are, after all, very similar to so many others which have been described or shown to the Institution from time to time.

It may or may not interest the members to learn that Handsworth possesses every municipal requirement and equipment, but a recital of the size and cost of the various undertakings could hardly afford any useful instruction to members of the Institution. Suffice it to say, that we have parks, recreation grounds, libraries, elementary, technical, and art schools, public baths, tramways, electric light and power station, fire stations, refuse destructor, and a splendid sewerage (separate) system, although thirty-five years old.

Instead of enlarging upon the great amount of money spent on public works, the Author would point out that so much work has always been done out of the current rates, that with a rateable value of 298,922*l.* the total indebtedness of the district on loan account, under Sanitary Acts, is only 157,534*l.*

The Author wishes in this paper as well as in the programme of inspections, to pass lightly over the works or establishments of an ordinary nature, which probably are no better than can be seen by the members elsewhere, and would rather devote more time to items which are dissimilar to those met with at nearly all our meetings. The programme and this paper are therefore mainly devoted to three points: (1) a few traces of those Handsworth pioneers of engineering, James Watt, Matthew Boulton, and William Murdoch; (2) the electrically driven and automatically controlled sewage pumping station at Witton, and some of the troubles experienced with the ferro-concrete underground tanks; (3) the "Leather Road" experiments.

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WATT, BOULTON, AND MURDOCH.

The Author would not attempt in a short paper like this to give even a slight sketch of the lives or the work of the three great contemporary engineers who, about a century ago, lived and worked, died and were buried, at Handsworth. Every member of the Institution must be perfectly acquainted with the details of their lives from Smiles's "Lives of the Engineers" (vol. iv.): "Boulton and Watt," and other engineering histories; but as it is possible still to see their dwellings, some of their workplaces, and much of the work which they actually did, the Author thinks it would be of interest to engineers of to-day to follow up what traces are left.

James Watt's residence was Heathfield Hall, now occupied by George Tangye, Esq., J.P., who has the fine and interesting collection of tools, machinery, and inventions, as well as many letters and personal belongings of James Watt.

It may not be generally known that James Watt invented the letter-copying press, also the first metallic pen, which, by the way, was fashioned out of a threepenny bit.

The story of Soho is indeed a classical episode in the world's industrial history. It has a voluminous literature of its own, and among the standard works on the subject is Dr. Smiles's book, mentioned above.

It contains a number of interesting woodcuts illustrative of "Old Handsworth," including two pictures of the Waggon and Horses Inn, which formerly stood on the spot where this meeting is now being held. It was a wayside posting-house on the London to Holyhead road, and in its great kitchen foolish Dick Cartwright gave away the secret of James Watt's new rotary engine.

The historic Soho Factory was demolished in 1862, but fragmentary vestiges of its foundation are to be seen to this day, lying between South Road and Hockley Brook.

Matthew Boulton lived at Soho House, which at that time stood on a very pleasant hill overlooking the valley in which his works and mint flourished. This house has in recent years been used as a private school for girls, but is now vacant.

An incident in connection with the London to Holyhead road may be interesting. When Telford was constructing this great national coach road a lawsuit arose concerning the portion of it

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passing through Handsworth. In 1824, Boulton's son brought an action against the Clerk to the Trustees of the Wednesbury and Birmingham Turnpike Roads. In making the improved coach road Telford had raised the level of the valley at Hockley Bridge, the present boundary between Handsworth and Birmingham, by 6 feet, and lowered the Soho Hill section a further 7 feet by means of a cutting. It was complained by Boulton, whose residence stood in fifty acres of land on the crest of the hill, that the levelling had interrupted the access to his pleasure grounds, and permanently injured the estate as prospective building land. Damages were laid at 10,000*l.* There were produced in court an extraordinary number of plans and models of the estate, showing its landscape features, all made quite realistic by the addition of numerous figures of men, and cattle, and vehicles. In fact, all the mechanical resources of the famous Soho Factory seem to have been called into requisition, till the opposing counsel ridiculed the whole display as a mere "puppet show." Jonah Robins, a well-known local surveyor, said that the "town of Birmingham was travelling very fast towards Handsworth," and this estate would become very valuable building land. The parish surveyor, Kempson, thought the estimated amount of the damages had been *placed too low.* The defence was that the work had been done under the direction of Mr. Telford, who was fully authorised under the General Turnpike Act of 3 George IV. A special jury had no hesitation in finding a verdict for the defendant, the work, in their opinion, having been done properly, and with all due care.

William Murdoch lived at a pleasant house on Sycamore Hill. Part of the grounds of this old house have now been taken into the stabling and premises belonging to the Council's Destructor Works, and the hill surrounding the house has been dug away for the sake of its fine bed of gravel. The house is now in a dilapidated condition, and will probably be demolished before long. The pulling down of parts of the house a few years ago exploded the popular idea as to the silver gas pipes which Murdoch was supposed to have used in lighting the house, as they were found only to be made of some common metal.

The well-known story about Murdoch's wooden hat, related in Smiles's "Lives of the Engineers," is said by Miss Emily Murdoch Walton, a great-granddaughter of the inventor, to be

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a pure fabrication. The conversation between Murdoch and Boulton on the subject is quite imaginary. Dr. Smiles was correctly informed that William Murdoch did turn a wooden hat as a specimen of his skill, but the tale as generally related he thought too good to alter—and everybody now believes the anecdote or prefers not to disbelieve it.

For much of the above history the Author is indebted to his friend Mr. F. W. Hackwood's "Handsworth, Old and New."

Witton Sewage Pumping Station.

At the east end of Handsworth is a low-lying area of about 300 acres of land which is situated below the level of the Handsworth Sewerage system, and consequently has always drained into the river Tame. Occupying about one-third of this low-lying area is situated one of the largest manufacturing concerns in the country, viz. the works of Messrs. Kynoch, Ltd., where principally ammunition is manufactured, but there are other departments for the manufacture of such varied articles as bicycles, soap, candles, and gas engines; also a large iron-foundry, and printing and bookbinding works.

The Holdford Road site, containing 1547 square yards, was purchased for a pumping station, and in 1898 a scheme was prepared which provided for brick storage tanks and pumps driven by gas engines. The estimated cost was 6318*l.*, but as it was found to be inadequate a scheme was in 1900 prepared by the Author which provided for the construction of the tanks in concrete and brickwork with a backing of asphalte sheeting, the thickness of the walls at the base being 7 feet and battered to 5 feet thick at the top, the floor being 4 feet thick, strengthened with expanded steel.

The dead weight of the structure, including machinery and buildings, was calculated to be more than twice the upward pressure of the subsoil water, without taking into account the value of skin friction between the outer face of the walls and the surrounding earth.

Alternative schemes were prepared for draining the area by a gravitation sewer to pass through the District of Erdington to the outfall works at Saltley, and to be constructed jointly by Handsworth and Erdington, at a total cost of 13,000*l.*, also for a gravitation sewer to be laid by Handsworth alone. The

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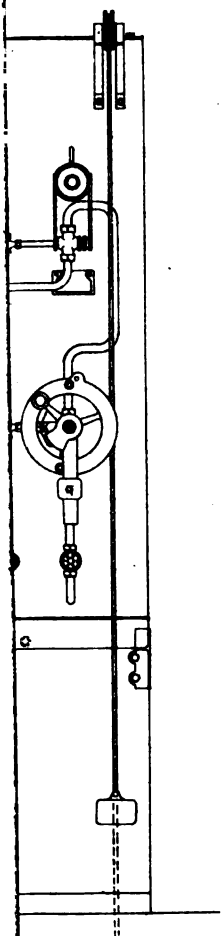
PLATE Nº 1.



ENGINEER AND SURVEYOR'S DEPT
COUNCIL HOUSE
HANDSWORTH
JULY 16TH 1911 H.K.T.

Nº 1812-T

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available fall being only 7 feet 6 inches in a length of one and two-thirds mile, and the gradients 1 in 868 for two-thirds of the distance, and 1 in 2456 for the remainder. The estimated cost of the latter scheme was 14,537*l.*, including subsidiary sewers, but exclusive of wayleaves.

Eventually negotiations for the joint sewer fell through, and the Council called in Mr. J. T. Eayrs, M.Inst.C.E., to report upon the other schemes. Mr. Eayrs recommended that the pumping scheme should be adopted, and suggested that the tanks might be constructed in Hennebique ferro-concrete, which suggestion was accepted.

Before the scheme was prepared, gaugings had been taken of the quantity of sewage coming from Messrs. Kynoch's works during 25 days and nights in dry weather. The quantity averaged 10,131 gallons per hour from 7 a.m. to 7 p.m., and 6581 gallons per hour from 7 p.m. to 7 a.m., or a total average flow of 200,544 gallons per day.

The only other buildings on the Witton area were 130 dwelling houses, and the quantity of sewage from these was about 19,500 gallons per day, or less than 9 per cent. of the total flow; but assuming the whole area will eventually be covered with small houses, the total dry-weather flow of sewage to be pumped will be 620,000 gallons per day or 69 cubic feet a minute, which, multiplied six times according to the Local Government Board requirements, makes the maximum flow of sewage to be dealt with 3,720,000 gallons = 16,607 tons per day, or 413 cubic feet per minute.

The sewage from Messrs. Kynoch's Works is at present greatly in excess of the sewage from houses, and from tests which have been made the sewage is proved to be very acid in character, containing a solution of sulphate of copper and dilute sulphuric acid from the metal pickling process. As it is absolutely essential that no acid waste of any kind shall come in contact with the pumps, Messrs. Kynoch, Ltd., proposed to treat the sewage in a copper recovery plant, which would send it in a neutral condition to the pumping station.

The quantity of sewage entering the works is measured in the gauging chamber; it is then screened, passes into the storage tanks and thence to the pump well, from which it is raised by the pumps and forced through an 18-inch cast-iron rising main up Witton Road to the main sewer in Aston Lane.

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The storage tanks are constructed in duplicate; they are 20 feet deep, and have a total capacity up to the inlet level of 264,342 gallons, being about an average day's dry-weather flow.

The tanks are ventilated by a Webb's patent sewer gas extractor and fume cremator, which also serves to light up the outside premises, and there is an air space of 12 feet above the maximum quantity of the sewage allowed in the tanks.

Pumping Machinery.—Before describing the pumping machinery in detail, a few notes of the duties the station is designed to perform will be useful.

The station is intended to be entirely automatic, and although one man is engaged, who lives on the premises as caretaker, his presence is not required so long as everything is normal, except part time for cleaning the machinery.

Owing to the intermittent flow of the sewage, the pumps were arranged to start and stop automatically, being controlled by floats in the pump well. In case of anything going wrong with the pumps, failure of current, or sudden storms overloading the station, an alarm bell is rung in the adjoining house, which calls the caretaker, who can start the motors by hand, or, if necessary, communicate with the generating station by telephone.

The pumps are controlled by the switchboard clock, and are for convenience cut out of action during the "peak" load on the generating station. Pumps, motors, switchboard, etc., are all in duplicate. The pumps of the centrifugal type, made by Messrs. Tangyes, Limited, of Birmingham, are each capable of raising 3,844,800 gallons per day, or 427 cubic feet of sewage per minute. The total lift is 23 feet.

Any deficiency of water in the pumps, brought about by evaporation or leakage, is made up by the admission of water from the water main to the pumps by means of a ball valve controlling apparatus, so that the pumps are always kept fully charged and ready for work.

Each pump is connected directly by floating coupling to one open type motor of 50 B.H.P. to work with 460 volts continuous current running at 460 revolutions per minute. Continuous lubrication is effected by means of special pattern oil rings.

The motive power is supplied by the Council's Electric Generating Station, which is about two and a half miles from the pumping station.

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The buildings are made sufficiently large to accommodate additional plant if required.

Switchboard and Automatic Starting Gear.

The letters in this description refer to the accompanying diagram.

As it was most desirable that the motors should be switched on gradually and off sharply, the rise and fall of a float cord was not considered a suitable motion to apply to both operations, and therefore what is here called the "water engine" was designed to perform these operations.

The automatic gear is dependent upon floats in the pump well and a water engine (A). When the sewage in the tank rises, a float cock (B) is opened by the movement of the float, and admits water from the supply main to the ram of the water engine (A); as the piston rises it slowly switches on the current by moving the starting lever (C) of the motor, by means of a chain. The admission of water to the ram is further controlled by an electrical magnet (D) actuating a safety cock (E), by means of which the bye-pass (F) carries the water to the waste tray (G); this comes into operation in case of an overload or if the supply of electric current is cut off.

The float cock consists of a grooved wheel (H) around which the wire cord from the float passes, and is continued to a counter weight. When the wheel is revolved by the float a pin engages with the weighted arm (J) and slowly raises it until it is past the vertical; the arm then falls, and in its travel opens a water supply valve by means of a cam (K), admits water to the ram of the water engine (A) and starts the motor. As the sewage is pumped out of the tanks the float falls and rotates the grooved wheel in the opposite direction, and the weighted arm falls over and closes the water supply valve. The load is not taken off the motors gradually, but when the ram gets to the end of its stroke it presses a button which instantaneously cuts off the electric current. The safety cock (E) is under normal conditions closed, but if the magnet (D) becomes demagnetised a weight falls and closes the valve on the pressure water supply pipe to the ram, opens the safety cock, and the water is bye-passed to the waste tray (G).

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The motor starter (L) is of the standard pattern, in a cast-iron case, with two electro-magnets, one of which acts on the safety cock magnet (D) in case of overload. (M) is the main switch, (N and N) the main fuses, and (O) the field for regulating the speed of the motors.

If the water engine should fail the motor starter can be worked by hand by the lever (C).

As the pumping, except in case of emergency, is not bound to be done at any particular part of the day, a clock switch (P) is provided on the switchboard, containing a switch connected to the magnet of the safety cock. This was adopted so that the pumps should not come into action during the "peak" load on the Generating Station. At this time the switch is closed, and the magnet (D) of the safety cock (E) releases its armature and shuts off the motors.

Should the storage tanks be insufficient to hold any abnormal flow during the "peak time," the cut-out arrangement is over-ridden by a high-level float which brings the pumps into action again before the sewage reaches the level of the emergency overflow from the tanks.

This overflow is quite adequate to prevent all risk of flooding at the station.

The automatic gear on the switchboard performs the following duties :—

(1) When the sewage has accumulated to a fixed height in the tanks the first pump commences to pump it out.

(2) When the sewage is pumped out the pump stops.

(3) If the first pump is not able to cope with the sewage quickly enough the second pump is automatically started.

(4) If an excessive load occurs on either pump that pump stops.

(5) If the pressure of electric current fails both switches return to the "off" position.

(6) During the hours of "peak" load on the Generating Station the pumps are stopped.

(7) In case of great emergency, the cut-out during "peak" time is over-ridden, and the pumps start irrespective of time.

(8) If the automatic gear fails to act, or if an overload stops the pumps, a bell is rung in the caretaker's house, and he can start the motors by hand.

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Cost of Works.

	£	s.	d.
Storage Tanks	3437	17	9
Rising Main, Sewers	1393	5	6
Buildings	1280	11	1
Pumping Machinery	974	14	5
Sundry items	669	7	5
Total	£7755	16	2

Underground Storage Tanks in Ferro-Concrete.

Like the doctor's "interesting case," perhaps one of the most interesting features from the engineer's point of view in connection with the ferro-concrete tanks was their behaviour when they were subjected to the pressure of the subsoil water.

The excavations for the tanks were sunk in very wet soft sand-stone, the site being only 150 yards from the river, and on nearly the same level. The subsoil, five feet down from the roof of the tanks, was principally made-ground and clear of water, but below that level to the bottom of the tanks occurs a soft sand rock which is full of water. This was of course drained to a sump, and pumped away during the whole time the tanks were in course of construction and when the work was complete, the shuttering was withdrawn, and the working space all round the tanks filled in, the subsoil water pumps were stopped and the water outside the tanks allowed to resume its normal level.

It was known that the dead weight of the tanks themselves, except a small portion upon which the engine house is built, would be insufficient to maintain their stability against the upward pressure of the subsoil water, and the designers of the tanks adopted means for anchoring them down. If the diagram is referred to, it will be seen that the floor of the tanks is extended outwards to make a projecting sill all round, 18 inches beyond the outer face of the walls. This should have had the effect of anchoring down the tanks and enabling them to resist the upward pressure of the subsoil water which stands at a height of 16 feet above the floor of the tanks. As the subsoil water began to attain its normal level it was found to be lifting the tanks at the end furthest from the engine house, and as the water increased in height so the tanks came further out of the ground. The maximum displacement was 6½ inches. The

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subsoil water pumps were at once re-started and the water level lowered, water being at the same time admitted into the tanks so that the levels inside and outside were soon equal, the result being that the tanks went back into position with practically no damage done to the tanks and none whatever to the engine house, the only serious fracture being where the inlet pipes passed through the walls of the tanks. Apparently the reason why the anchor or sill was ineffective was because it was covered only with the filled-in material around the tanks, which compressed as they rose. This was afterwards remedied by filling the trench all round the tanks with concrete as shown on the diagram.

This is rather an interesting point to engineers, because constructions of this character in brick or ordinary concrete, the walls and floors of which would probably average 5 to 6 feet thick and would generally be heavier than the water which they displace, would require no special means to keep them in position when once constructed, but with ferro-concrete construction, which is comparatively of such a light nature special means must be provided for anchoring them down in water-logged ground, or they would be liable to float like a ship.

The strains were severe and complex to which these tanks were subjected by the pressure of water when being held down by the weight of the engine house over a very small area at one end, and also by the large cast-iron pipes which were built into the wall at the other end.

In the Author's opinion it is a tribute to the value of ferro-concrete construction that, in spite of the extraordinary strains to which it was subjected, the whole of the work settled back into position as a monolithic construction with practically no damage done.

"Broughite" or "Leathern Roads."

Macadam road builders have hitherto striven to obtain a road hard, rigid and unyielding, to induce the stones to lie still in their beds and at the same time to reduce attrition and dust which naturally go together.

Although very hard roads have their drawbacks, such as giving less grip for rubber tyres, being bad for horses, and noisy, the proposal to give a macadam road a certain amount of

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"cushion" may be regarded as heterodox, yet this can be attained without getting either attrition or a cracked surface.

In conjunction with Mr. Sam Brough, a leather merchant of Handsworth, the Author has during the last year or so been experimenting in the use of waste leather for the purpose of roadmaking. The material is known as "Broughite," and is a mixture of certain proportions of scrap leather with any good stone or slag after treatment with tar and bitumen, the proportions being varied according to the class of traffic to be carried.

A length of "Broughite" was laid at the rear of the Council House a year ago and shows practically no signs of wear. The traffic over it includes all the Council's horses and carts, fire engines, and tradesmen's vehicles. Another length is now being laid in Stafford Road adjoining the Public Works Depôt, which the members will have an opportunity of seeing.

In addition to its durability and freedom from dust, the great value of the material lies in its resilience, which greatly reduces the noise, especially from heavy vehicles, and is much more comfortable for horses, affording them a good foothold and much less "jar" to the feet and legs: it also affords a good grip to rubber tyres.

The cost is no more than that of any good bituminous macadam, being in this district 2*s.* to 2*s.* 3*d* per square yard for 3½-inch coat laid on existing foundation.

King Edward's Grammar School for Girls.

This school is erected on the site in Rose Hill Road, by the Governors of the Schools of King Edward the Sixth in Birmingham.

It is built in brickwork, with stone facings, in Classical style of architecture, and will accommodate 450 girls. There is a gymnasium in the basement, on the ground floor is situated an Assembly Hall 100 feet by 44 feet, and 40 feet high, cookery room 55 feet by 24 feet, dining-room 42 feet by 25 feet, library 47 feet by 29 feet, mistresses' room 32 feet by 25 feet, 9 classrooms, etc. On the first floor is situated the upper part of Assembly Hall, 10 classrooms, art rooms, lecture room, chemical and physics laboratories, needlework and sewing-room, dark room for photography, storeroom, hospital, etc.

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The estimated cost of the school, exclusive of the site, is 45,000*l.*

Rose Hill Road extension, authorised by the Handsworth Urban District Council Act, 1911, will provide direct access to these schools from the junction of Soho Road with Villa Road.

Arrangements can be made for members to inspect any of the following public works, which are not included in the programme, any time before or after the meeting:—

PUBLIC BATHS, including Turkish, Russian, swimming baths, etc., were erected in 1907, and cost 24,500*l.* The water is raised by an electrically driven pump from a borehole 500 feet deep, yielding 12,000 gallons of water per hour. First-class swimming bath 100 feet by 35 feet.

ELECTRIC LIGHT AND POWER STATION, erected in 1905, at a cost of 74,000*l.*, including 27,000*l.* for mains and services. The undertaking was designed by Sir Alexander B. W. Kennedy and his partner.

REFUSE DESTRUCTOR, containing 8 cells, erected in 1898, cost 7813*l.* This has since been remodelled. The depôt buildings cost 3530*l.*

Stables and loose boxes for 24 horses, workshops and cart-sheds, erected in 1901, cost 11,798*l.*

Disinfecting station, erected in 1901, cost 702*l.*

PUBLIC WORKS DEPÔT AND STABLES, for 14 horses, erected in 1877. Branch depôt and stables for 4 horses at Birchfields, erected in 1906.

FIRE BRIGADE STATION, erected in 1899, cost 2223*l.*, including accommodation for ambulance van and 3 fire engines, loose boxes, workshop, and recreation room.

TECHNICAL AND ART SCHOOLS, with large lecture theatre, engineering, metallurgical, and chemical laboratories, wood-working rooms, and large well-equipped lecture rooms, erected in 1897, cost 14,980*l.*

NEW COUNCIL'S ELEMENTARY SCHOOLS, erected at a cost of sums varying from 14,000*l.* to 28,380*l.*, built on the most up-to-date lines, and containing every modern requirement. There are special science, handicraft, and domestic departments attached to three of the schools, which are quite exceptional in a scheme of elementary education.

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THE CABLE TRAMWAY DEPÔT now out of use, but still containing the large winding engine and a rather ingenious arrangement for taking the "slack" out of the cable.

SUPPLEMENTARY NOTES.

Witton Sewage Pumping Station.—Pumping was done on 297 days during the year 1910–11, and averaged 25·7 minutes; the actual quantity of sewage pumped, averaged 68,200 gallons per day on each of these days.

The electric current used during the year was 5176 units, being an average of 17·4 units per day on which pumping was done. Each unit raised 3920 gallons of sewage.

Pressure of current at power station, 460 volts. Pressure of current at pumping station averages 435 volts. Distance, about 2½ miles.

ANALYSIS OF COST OF PUMPING YEAR 1910–11 PER 1000 GALLONS (LIFT, 23 FEET).

For current	0·37*d.* per 1000 gallons
For labour, materials, repairs, and renewals ..	1·08*d.* do.
Total cost	1·45*d.* per 1000 gallons

Level of overflow from tanks, 301·75 above ordnance datum; normal river level, 297·82 ditto; high flood level, 300·32 ditto; highest recorded flood level, 302·72 ditto; ground level of pumping station, 305·00 ditto.

The floats in the sewage tanks which actuate the automatic gear on the pumps are made of artificial stone.

Weight of load on top of tanks is 174 tons.

Approximate cost per cubic foot of reinforced tanks, 10*d.*; engine house, 1*s.* 3*d.*; stores, 8½*d.*

The Local Government Board granted a loan for the reinforced concrete work for a term of fifteen years, and a loan for the remainder of the work for a term of thirty years.

Broughite or Leathern Roads.—Proportions of materials used for coating a measured area of 58 square yards of road, 3 inches thick: 4 tons of 1½-inch Leicester granite, 5 cwt. of leather, 42 gallons of distilled tar. The proportion is therefore 1 ton of broken stone, 1¼ cwt. of leather, 10½ gallons of distilled tar.

Handsworth Cemetery.

Leveretts Estate.—Seventy acres of land purchased at a cost

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of 300*l.* per acre. Forty acres drained. Thirty-five acres laid out (excluding Approach Road). Chapel, 5500*l.*; lodge, 545*l.*; service buildings, 641*l.*; plant house, 150*l.*; public conveniences, 82*l.*; subsoil drainage (40 acres), 4470*l.*; foul water drains and sewage disposal works, 385*l.*; road and path making, 4500*l.*; landscape gardening, 1086*l.*; Oxhill Road entrance gates, 273*l.*

DISCUSSION.

MR. S. S. PLATT: It was a happy idea to give us the details with reference to the connection of the early engineers, Watt, Boulton, and Murdoch, with this district. The work which appeals to me particularly is the sewage pumping station. It is certainly a clever piece of work, and judging from the description the automatic arrangement for starting and stopping the pumps is well worked out. I have pleasure in moving a hearty vote of thanks to Mr. Richardson for his paper.

MR. R. J. THOMAS: I have very great pleasure in seconding the vote of thanks to Mr. Richardson for his paper. We are told "there is nothing like leather," and it may be applicable to roads as well. I would like to know the proportion of leather waste used, and the cost. I do not quite follow the 2*s.* and 2*s.* 3*d.* per square yard; I presume that is the gross cost. If Mr. Richardson would add to the paper the increased cost due to the introduction of the leather and the proportion of leather in the aggregate it will be of interest.

MR. E. H. CRUMP: I should like to ask whether there is any charge made to Messrs. Kynoch for treating their sewage, seeing there is such a large amount as 200,000 gallons a day, and also the kind of gauge used for gauging the quantity. Mr. Thomas has asked a question about the leather road. We have a lot of leather scraps brought down from the boot manufacturers' works as waste. I have thought if these scraps could be used in road manufacture they would be very useful. Perhaps Mr. Richardson will kindly give us a description of the method of manufacture of this type of road.

MR. S. S. PLATT: Would Mr. Richardson kindly amplify the paper with regard to the pumping. The cost per thousand gallons? The lift is 23 feet, is it not? Where do you obtain the current from? Do you generate it yourselves at your own electric station?

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MR. W. O. THORP: I should like to ask whether the sewage tanks at the Witton pumping station were constructed under a loan from the Local Government Board or under the powers of an Act of Parliament. When we constructed some tanks six years ago at Malvern we had a discussion whether ferro-concrete was suitable for sewage disposal. Where there are acids in the sewage they are apt to destroy the surface of the concrete. The danger is, therefore, that these acids in the sewage in this particular case may disintegrate the concrete and injure the walls of the tanks. I notice Messrs. Kynoch's sewage is very acid, and that they propose to deal with it, but it is not stated whether they have carried out their intention? If the acids disintegrate the walls there is a danger of injury to the reinforcement. I would like to know whether the Local Government Board raised that point at all?

THE PRESIDENT: I will put the vote of thanks proposed and seconded to Mr. Richardson for his paper. I think it is only right to say that this district meeting would have been much more largely attended if it had been held at a different time of the year. We have always had large meetings in the Midland district; but this has been a hurried meeting, called at short notice, to complete the business of the Annual Meeting by confirming the resolutions to amend the Articles of Association.

MR. H. RICHARDSON, in reply: Mr. Thomas, in referring to the leathern roads, asked about the proportion of leather used. I shall be very pleased to incorporate that in the paper. With regard to the doctor's "interesting case," I have several medical friends who discuss various matters connected with their own profession, and it always appears that to them the most interesting thing in the world is a case which is going wrong or is about at its worst; and where the mere layman would think the patient might be, in engineering parlance, thrown on the scrap-heap, the doctor begins to find additional interest in the case. It was from that point of view the words were used. It would be more interesting to see a thing which had not acted in the way that was expected, than to show you what has been done as well elsewhere. That is the case with the ferro-concrete construction at Witton, which did not act as it ought to have done. It is interesting to see what has happened, and how it occurred. With regard to Kynoch's sewage, we do charge Kynochs very

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heavily for dealing with their sewage; but they pay it in their rates along with the other ratepayers of the district. They have not completed their sewerage yet. Their works cover 100 acres, and it is a big thing to turn over their drains from the river to the pumping station. Consequently we are not yet getting the whole of their sewage, and the pumping station is only doing a very small amount of work as compared with what it will have to do. We shall be able to show you this afternoon how it does work; but I cannot give you any conclusive figures as to cost, because we are not working at full load. In reply to Mr. Thorp, the tanks were built out of a loan, and I shall be pleased to add a few figures with regard to the pumping station which I have not given in the paper, because I have treated it from this point of view—things which went wrong and how we cured them. If the members wish it I shall be pleased to give all the particulars as to loan and cost of construction. The Local Government Board granted a loan for fifteen years for the Hennebique work, and thirty years for the remaining cost. For energy we pay 2*d.* per unit for the first 200 units per quarter and 1½*d.* per unit for the rest. This is the ordinary charge to power consumers in the district, the charge for lighting being 4*d.* per unit. The cost of pumping on the small scale we have been working is 0·37*d.* per thousand gallons for current and 1·08*d.* for labour, material, and repairs, a total of 1·45*d.* per thousand gallons. For each foot of sewage in tank B the capacity is 1882 cubic feet, which is equal to 11,762½ gallons. As to the quantity of scrap leather obtainable for road making, I am informed by the gentleman interested in this that he can get 40,000 tons from one town, and there is plenty to be got from other places.

The members then proceeded in motor cars, generously provided by local gentlemen, to visit the new girls' schools of the King Edward's foundation, the electrically-driven pumping station for dealing with the sewage of Messrs. Kynoch's works, the Handsworth Cemetery, and Messrs. Tangye's Cornwall works, where they were entertained to tea, and subsequently inspected the Watt Museum.

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SPECIAL GENERAL MEETING.

July 29, 1911.

Held in the Council House, Handsworth.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE PRESIDENT: I am very pleased to inform you we have the number of members present, as required by law, to carry out our Special Meeting to confirm the resolutions passed at the Special General Meeting of the Institution held at West Bromwich on July 5. I will call upon the Secretary to read the notice convening the meeting.

MR. T. COLE, Secretary, then read the notice convening the meeting.

THE PRESIDENT: I will move the first resolution—

"(1) That the memorandum of association be altered as specified in the print annexed to the notice of the meeting of the 5th July, 1911." *

MR. STUBBS: I have very great pleasure in seconding that.

The resolution was then carried unanimously.

THE PRESIDENT: Now I beg to move—

"(2) That the articles of association be altered as specified in the said print, except that Article 22 shall be as follows:—

"(22) If within thirty minutes after the time fixed for holding the meeting a quorum is not present, no meeting shall be held

* The proposed alterations were duly set forth in the notice convening the meeting.

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and all matters which might, if a quorum had been present, otherwise have been done at a general meeting (other than a special meeting) may forthwith be done on behalf of the meeting by the Council."

MR. GAMMAGE: I have pleasure in seconding that.

The resolution was carried unanimously.

A hearty vote of thanks was accorded to the Chairman of the Handsworth District Council for the use of the council chamber.

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EASTERN DISTRICT MEETING.

September 23, 1911.

Held at Gidea Park, Essex.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

MR. R. A. MACBRAIR was unanimously re-elected Honorary Secretary for the Eastern District.

Special General Meeting.

The Notice convening the Meeting having been read, the following resolutions were passed unanimously:—

(1) That the Memorandum of Association be altered as specified in the annexed print.*

(2) That the Articles of Association be altered as specified in the annexed print.*

(3) That the necessary application be made to the Court for the confirmation of the alterations specified in Resolution 1.

The Members then proceeded to inspect the housing exhibition at Gidea Park. Several types of houses, erected at a cost of either 375*l.* *or* 500*l.*, *were on exhibition, and were inspected with much interest.*

* The proposed alterations were duly set forth in the notice convening the meeting.

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SOUTH WESTERN DISTRICT.

September 30, 1911.

Held in the Urban District Council Offices, Paignton.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

DR. COLLIER, Deputy Chairman of the Urban District Council, welcomed the Members to Paignton.

The President thanked Dr. Collier on behalf of the Institution, for the hearty welcome given to the Members.

MR. T. MOULDING, Honorary District Secretary, read the Minutes of the Torquay Meeting, which were confirmed.

Mr. Moulding was unanimously re-elected Honorary District Secretary.

MUNICIPAL WORKS AT PAIGNTON.

BY C. OWEN BAINES, *Member*,
SURVEYOR TO THE URBAN DISTRICT COUNCIL, PAIGNTON.

THE history of Paignton is being dealt with separately, hence the Author will pass straight on to describe the works carried out by and under the Council during the past seven years.

As this is the first time the Institution has officially visited Paignton, the Author has great pleasure in giving all the members present a very hearty welcome, and trusts that by the time the day is over all will have fully benefited by their visit.

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RELAYING OF SEA OUTFALL.

Surveyor's Return to the Surface after an Inspection.

INTERIOR OF A CONVENIENCE—PAIGNTON.

A SHELTER—PAIGNTON.

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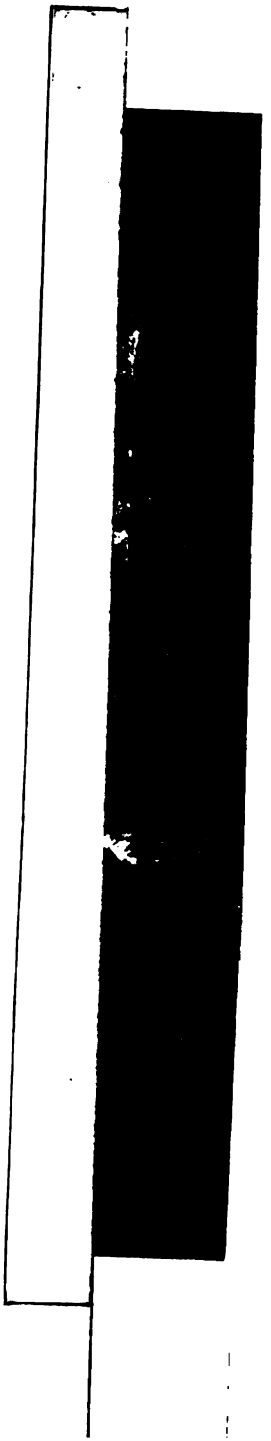

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Parks and Pleasure Grounds.

Victoria Park.—The Victoria Park was acquired some years ago from various owners, chiefly the Dendy Estate. It consisted more or less of salt marsh, with numerous fresh-water streams running across it at all angles, the chief source of these being Paignton well.

The land was raised, planted out, streams diverted, ponds formed with stone revettements, and so arranged that fresh water continually passes through. Various species of wildfowl, swans and other water birds are safely reared in considerable numbers. The plants and trees include the *Micro carpa*, euonymus, eschalonia (white and crimson), flowering bays, box, New Zealand flax (golden and variegated), white lilac, Japanese shrubs of various kinds, pampas grass, lumac, drascenas and other palms, etc., all thrive luxuriantly. There are about 15 acres in all.

Queen's Park.—This land was acquired under special Act of Parliament in 1898, and is about 7 acres in extent, being used in the summer for tennis, croquet, bowls, cricket and various fetes, archery tournaments, and in the winter for foot-ball and hockey. So great is the demand for this park that both winter and summer use make it very expensive, and, indeed, difficult to keep the turf in passable condition. The land was originally more or less salt marsh, and has been gradually reclaimed from year to year ever since. Personally, the Author wishes it was a yard above the present level, but financial considerations were in the way. Charges are of course made to the various players and clubs who use the ground.

Cost of land, 5000*l.*

Conveniences.—Two sets of conveniences have been erected and in use for the last two years, the larger one on the sea front adjoining the main shelter. The sanitary fittings, tiling, and appliances are of the very best, and were supplied by Messrs. W. C. Farrer, Ltd., Birmingham. There are twelve urinal stalls, four w.-c.'s and two lavatory basins in the men's section, and four w.-c.'s of special design, and two lavatory basins in the

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ladies' section. The woodwork is of best Burmah teak, and the roof, Helliwell's patent glazing. It is lighted by electricity, and provision is made for an electric exhaust fan. The desire has been to obtain brightness and light into these places on the grounds of health.

Each w.-c. pan is connected with the drains by means of a brass union and putty joint, so that in case of a blockage the pan may be readily detached.

The divisions are of 1-inch Sicilian white marble, and fit into the teak studs resting on bronze sockets and supports which are dowelled into the concrete under the tiled floor. Three more on similar lines are proposed to be erected during the next few months. The income is already sufficient to pay sinking fund and interest on the 1000*l.* expended.

Tramways.

These have been constructed by a local company under powers obtained by Act of Parliament by arrangement with the Council, linking us up with Torquay. The overhead or trolley system has been adopted with very satisfactory results, the work being only commenced at the end of April last and completed by the first week in July, when the first tram came through, the work in our district occupying only nine weeks and two days.

The total expenditure estimated for these works, including the conversion from the Dolter system to the overhead system in Torquay, was 60,000*l.*

Important widenings have taken place at various places *en route*, and a new trunk road, 2000 feet long by 42 feet wide, has been constructed, along which the tramway track has been laid. 1000 feet was done by Mr. Paris Singer at his own cost, besides giving the necessary land, and the remaining 1000 feet by the Council, Mr. Singer again giving most of the land required. The gentleman mentioned is laying out an extensive estate, and will be spending something like 20,000*l.* during the next five or six years on roads and other improvements.

The track is double, and has crossovers at various points; gradients are not severe, the sharpest being 1 in 13. The narrowest curve has a radius of 36 feet at Hyde Road corner.

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Green and Foreshore.

The whole of the sea front, green and foreshore between the Redcliffe Hotel and the club belongs to the Council, having been given to the town by the Fletcher Trustees and others, besides other portions along the frontage of the coast line traversed by the district.

Bathing Tents and Chairs.

Bathing tents are owned and run by the Council under the supervision of the writer's department, also the chairs for visitors using the beach and green. The moderate charge of 2*l.* 10*s.*, including tent, rent of site, &c., is made per tent for the season. Mixed bathing proceeds from these tents. Last year the chairs repaid the whole of the capital expended upon them, besides working expenses.

South of the pier is left for bathing machines and general use. No amusements are allowed there. A nominal charge of 2*s.* 6*d.* per machine is made for the season upon the company which owns them, and no advertisements are placed thereon or therein.

Streets.

The streets and public roads comprise 80 miles, and are all macadamised. About 40 miles of these may be regarded as urban or town roads, and the remainder are typically Devonshire lanes, being clothed at the sides with all varieties of verdure, such as bluebells, primroses, foxgloves, wild iris, and innumerable ferns of all kinds. These lanes require a great deal of attention, notwithstanding their rural character. They are subject to frequent and considerable damage by storms owing to the sharp gradients usually found.

Targranix Road.

A section of the Marine Drive, 300 yards in length, has been laid with Targranix, as a matrix with our local limestone; it is now in its fifth year of existence, and has only just lately had a few shillings spent in repairs since it was laid, notwithstanding the fact that during the late autumns and early springs waves break over and on to it. The cost of laying this was 1*s.* 8*d.*,

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per super. yard, including a good deal of ballast, which was used to form the camber of roadway. The surface is non-slippery and impervious to moisture, and its present appearance and condition speaks for itself. The price could have been considerably lessened had a larger area been treated.

Quarries.

The Council owns its own quarries, one at Goodrington and the other at Yalberton (within the district), from which 10,000 tons of stone are annually obtained in the shape of macadam, kerb, channel, &c. The greater quantity of macadam is hand broken, and the remainder is broken by means of Baxter machines.

In addition to the above, quantities varying from 1000 to 1500 tons of Trusham granite have been used in certain years. This stone is extremely hard and eminently suitable for use on the main roads where heavy and frequent motor traffic is the rule. It forms a good surface, is restful in colour, and when once set does not readily become loose.

Tar Spraying.

Three years ago the Council purchased a tar-spraying machine of the Lewellins & James' type. We use crude tar from the local gasworks, mixed in certain proportions with distilled tar from Harveys, of Plymouth. The proportions vary between 1 to 8 and 1 to 6, according to the quality and consistency of the crude tar. General weather conditions also have an influence. The cost per super yard is about ¾*d.*, sometimes more, according to distance from depôts. On occasion we have done it at a trifle less than this.

The sand is usually put on after about three hours have elapsed, and is obtained from the River Dart. But there are occasions when the exigencies of traffic require immediate spreading of the sand, and vehicles to use the roadway.

Tar spraying is much appreciated, for not only is the dust nuisance mitigated, but noise from traffic is immensely reduced, and yet, again, far less damage is caused to the macadam by attrition and weather variations.

In a day's work we usually dispose of from about 460 to 750 gallons of tar, and sand the tarred area as well. The

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hot ammoniacal liquor or water is sprayed out as a weed-killer where required. The tar adheres to the limestone very well, much better than other classes, such as granite. It is absolutely essential for successful tar spraying to have a *good* and *dry* surface, clean and free from dirt of every kind. The road should be swept over and over again with the horse broom, and a man should follow even then to clear off anything of an adhesive nature. Clear, dry, and warm weather is usually chosen for this work.

Our experience proves that only distilled tar gives best results, as can be seen in the town; some of the roads have not been touched again since April last.

Other expedients have been resorted to in order to mitigate the dust nuisance with varying degrees of success. Chloride of calcium proved very efficient, but the cost of delivery here was too much.

Cemetery.

The cemetery comprises about 5 acres, and contains chapels and caretaker's lodge. It was purchased about thirty-three years ago. The loan now having been paid off, the establishment charges are considerably reduced.

Allotments.

The Council rent from landowners three sets of allotments, one at St. Michael's, the second at Colley End, and the third at Preston—total area about 10 acres. They are readily taken up whenever a vacancy occurs, being fairly central in those parts of the urban area mentioned.

Lighting.

The town is lighted both by incandescent gas and electricity. The gasworks belong to a private company, whose charge is 3*s.* 2*d.* per 1000 cubic feet. The electricity works are also in the hands of a company whose Order is leased from the Council for a term of years, the lighting charge per unit being 3*d.*

The gas company have recently, by agreement with the Council, agreed to take over the whole of the 356 gas lamps, including lighting, extinguishing, cleaning, maintenance of lanterns and burners, providing new Sugg's patent "Windsor"

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lanterns and Kern burners, at an annual charge of 2*l.* 16*s.* for No. 4 burner and 2*l.* 6*s.* for No. 2 burner. The new lanterns and burners become the absolute property of the Council immediately they are fixed. The term covered by the agreement is five years, and the length of time each burner is contracted to burn is 1500 hours per annum. All-night lights are charged as two lamps.

There are fourteen arc lights of 1010 candle-power each, at an annual charge of 11*l.* 10*s.* for 1500 hours per annum. This includes the capital cost of standards, service, current, lighting and extinguishing, cleaning and general maintenance. Besides these there are three incandescent street lamps lighted by 50 candle-power Osram lamps.

By making the above arrangements, the Council have secured efficient lighting of the town. A spirit of competitive emulation naturally exists between the two systems, which leaves very little room for invidious comparisons.

Sewerage.

The system is on the combined principle, and is in effect practically a conservancy system, having storm overflow weirs into the harbour and beyond. There are, however, exceptions in one or two cases where separate storm-water conduits have been provided. This is becoming increasingly necessary owing to the growth of the town in all directions. Very numerous sewer extensions and constructions have been made during the past few years.

Sewer Outfall.

The end of the outfall is nearly 1000 feet beyond the outer wall of the harbour, and discharging well into the tideway. This was seriously damaged a few years since by a violent storm, the pipes being carried away. The work was, however, reconstructed and extended 100 feet further out to sea under the writer's direction, who used the diving dress and inspected the work under the sea. All was carried out by direct labour.

Refuse Disposal.

The collection is carried out by the men and horses of the Council, the central parts of the town being usually cleared

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before 8 o'clock in the morning. Until a year ago the refuse was received by the farmers, but owing to the development of the town the cost of carting became unnecessarily expensive; to say nothing of the nuisance likely to be caused to inhabitants who happened to live near the fields being treated.

An agreement was therefore concluded with the Electric Light and Power Company, under the Electric Lighting Order, leased from the Council, to construct a refuse destructor and undertake the destroying of refuse. A destructor was therefore erected of the "Sterling" back-feed type, by Messrs. Hughes & Stirling, of Arundel Street, London, W.C. The results so far have been very satisfactory, and the plant and tests are described as follows.

Destructor.

This plant was erected during 1909 for the Paignton Electric Light and Power Company, Limited, and is the most recent destructor installation at a seaside and health resort. Unlike most modern destructors, it was designed and erected with the sole object of disposing of the refuse of Paignton in a final and sanitary manner, and the production therefrom of a hard and innocuous clinker, so far as the character of the refuse permitted.

The destructor furnace, which has a grate area of about 25 sq. feet, is arranged with divided ashpits. The gases have a sideway motion over the grate into the combustion chamber; thence turning at right angles into the central flue of a small Cornish boiler 10 feet by 5 feet diameter. This boiler is erected upon saddles, without brick setting, the gases simply passing through the centre flue. The method of charging adopted is back shovel feed, an inclined roadway being provided which rises to a height of about 5 feet above the firing level; the bunker is constructed of concrete, having a suitable shovelling sill, so arranged as to be very convenient for the quick charging of the furnace with the minimum of labour.

Forced draught is provided by means of powerful improved silent steam jet blowers, drawing their supply of air through a steel air duct, coupled to a regenerator of special design; with vertical tubes fixed at the back of the boiler. The whole of the air for the forced draught is in this manner drawn from

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within the destructor building. After passing through the regenerator, the gases traverse a dust pit and pass to the chimney, which is 75 feet in height and constructed of brick.

The contract included the complete plant, buildings, chimney, approaches, drainage and water supply, and for the whole being carried out and the plant put to work within four months.

This small destructor furnace when tested upon completion, exceeded the guarantees very considerably, and is capable of burning over 18 tons of refuse per day of twenty-four hours, raising at the same time a great deal more steam than is necessary for the purposes of the works. The refuse burned at this plant is supplied by the Council to the Electric Light and Power Company, and the whole of the clinker produced is taken by the Council from the company, the Council paying to the company one shilling per ton for the burning of the refuse, and one shilling per ton for the clinker produced, the proportion of clinker to refuse being about 25 per cent.

Plant in use	One cell "Sterling" back-feed type with divided ashpit, steam jet blower forced draught single-pass Cornish boiler 10 ft. by 5 ft. suction type regenerator.
Nett weight of refuse burned ...	8 tons 4 cwts. 1 qr.
Test commenced with a clean fire ...	11.50 a.m.
Test finished with a clean fire ...	10.25 p.m.
Duration of test	10 hours 35 miuutes.
Capacity of plant per twenty-four hours	18 tons 15 cwts.
Refuse burned per square foot of grate area per hour	70 lbs.
Average boiler pressure throughout test	96 lbs.
Blowing-off pressure of boiler ...	94 lbs.
Maximum forced draught pressure in ashpit	2 in. (water gauge).
Temperature test in combustion chamber, taken at 7.45 p.m. double 18–16 gauge copper cable melted in	5 minutes.
Similar test, taken at 8.0 p.m. melted in	1 minute.
Temperature in combustion chamber, adduced from above	At least 2000 deg. Fahr.

NOTES.—The boiler had to be blown down at least once an hour throughout the test, in order to keep the pressure within limits. Material burned throughout the test was ordinary quality unscreened ashbin refuse. The weather conditions were fine and dry.

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Result of Test as compared with guarantees given.—The guarantee given was "the burning of 12 tons of domestic and trade refuse, to a hard and innocuous clinker in twenty-four hours." The excess obtained therefore over the guarantee, as set forth in the above figures, was no less than 52 per cent. A further guarantee was given that there should be no nuisance from the burning of the refuse. Throughout the day careful observation was made as to the fumes emitted from the chimney shaft. There was almost an entire absence of smoke of any kind. There was also no smell or other cause of nuisance about the works. With reference to the clinker, this was throughout the test of hard and good quality.

Recent Works.

That the Paignton Council is a thoroughly progressive body will be recognised when it is made clear that during the last seven years the following have been carried out :—

(1) Moorland water scheme, cost 111,000*l.*

(2) Water distribution, 13,000*l.*

(3) Sewer extensions, outfall and other improvements, 10,000*l.*

(4) Conversion of flat flame, to incandescent gas, burners for street lighting by contract.

(5) Installation of electric light and destructor works by contract and agreement.

(6) Acquiring of land for pleasure grounds.

(7) Construction of electric tramways.

(8) New sets of public conveniences of the most modern type, and others in contemplation.

The above works have necessitated three Acts of Parliament and one Provisional Order, while a further Act of Parliament was obtained by the Great Western Railway for doubling their line between here and Torquay, involving the erection of new bridges, road diversion, removal of the Livermead tunnel, etc. This work is nearing completion. With regard to the tramways, this work may be commenced at any time now. Road improvements are in progress chiefly for this purpose.

To refer, in conclusion, to the new trunk road, this is to be

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lighted by electricity, also the adjoining roads on Mr. Singer's land now under process of development.

Our time is necessarily very short for the reading and discussion of papers having regard to the length of our programme, hence the Author has not described in deep detail the various points and difficulties which naturally arose in carrying out the works entrusted to his department, but he will be most pleased to answer fully any questions put.

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THE PAIGNTON WATERWORKS.

By J. C. HAWKINS, Assoc.M.Inst.C.E., A.M.I.Mech.E.;
Water Engineer, Paignton.

The area of the parish of Paignton is 5312 acres, about one-half of which is below the 200 feet level, and the other half between 200 and 600 feet above Ordnance datum.

The population in 1881 was 4700, in 1891 it was 6783, in 1901 it had risen to 8400, whilst in 1911 the increase was 32 per cent., making the population 11,250.

The parish, being a very large one, only carries at the present time about two persons per acre, making the distribution of water somewhat costly, whilst the various new building estates are being developed.

The following description and account of the water undertaking will serve to show that the phenomenal growth of Paignton during the last decade was only rendered possible by the long-sighted policy of the Local Authority, and the present Council, realising the wisdom of the policy, and believing in the natural attractiveness of the town, continue to provide for the future Paignton.

The first Act of Parliament for waterworks purposes at Paignton was obtained by the Paignton Waterworks Company in 1863, and they continued to manage the water undertaking until the year 1888, when the Local Authority purchased all their rights in the supply.

The original works at Great Parks consisted at that time of a reservoir holding about 1½ million gallons, supplied from a spring rising in the valley, and two sand filters.

These works are situated about 2 miles west of the Paignton Railway Station, and the top water line of the reservoir is 182 feet above Ordnance datum. Since 1888 the reservoir has been enlarged to 3½ millions, and a second reservoir made to impound

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8 million gallons, also two additional sand filters and clean water tanks have been built.

In 1899, owing to a shortage of water on the low levels, and want of water on the higher levels, in order to develop suitable building sites, a Bill was promoted in Parliament, and the following year an Act was obtained (Paignton Water Act, 1900), by which powers were given to obtain a supply from Holne Moor on Dartmoor. Holne Moor is 4¼ miles north-west of Buckfastleigh, and 1 mile north-west of Holne, the birthplace of Charles Kingsley.

The works proposed were to impound the Venford Brook, a tributary of the River Dart, and generally to construct such works as were necessary to give the supply required.

During the passage of the Bill through Parliament the millowners on the River Dart opposed the scheme, and were eventually given 400,000 gallons per day as compensation, this was 100,000 gallons a day more than was estimated for, and necessitated raising the dam to the maximum limits of deviation, *i.e.* 54 feet, in order to provide storage for a sufficient number of days.

The Paignton Council wisely followed the admirable precedent set by Torquay, and purchased the drainage area, which consisted of some 740 acres of moorland, without a habitation of any sort upon it. Commoners' rights were extinguished in respect of the land covered by the reservoir, etc., and some 60 acres were fenced in to prevent direct pollution from Moorland cattle, etc.

The works constructed at Holne Moor included a masonry dam 618 feet long, which carries the main road from Buckfast to Princetown, a leat diversion, five sand filter beds, caretaker's house, meters, 16 miles 9-inch trunk main, and a bridge over the River Dart.

The foundations for the dam gave rise to much anxiety and trouble, so much so that the maximum depth of the trench excavated was 75 feet, and the estimated cost of the work was exceeded by 41,000*l*. The whole of the works were designed by, and constructed under the supervision of, Mr. F. W. Vanstone of Paignton, with Mr. Baldwin Latham as consulting engineer.

In 1907 the works were opened, and in a very short time,

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after some particularly heavy rains, the reservoir was filled, the storage obtained being 190 million gallons, with a top water area of 34 acres.

Owing to large patches of soft peaty soil on the watershed, the water at times, especially after heavy rains, has an acid reaction, and is therefore liable to act on lead. Mr. Vanstone made many experiments in order to find a medium for neutralising the acidity, and he finally adopted limestone, which was sandwiched in between the top and second layers of the sand filters.

In order at times to thoroughly correct the water the rate of filtration was slow, and the Council decided, after much investigation and discussion, to instal three Candy filters constructed to especially deal with plumbo-solvency, &c.

(Owing to an increasing demand for water it has been found necessary to instal a fourth Candy filter, which will probably be in course of erection at the time the visit of the Institution is made to the works.)

It may be of interest to describe in some detail the special construction of the Candy filters.

The Candy waterworks filters employed are a special patent compound type designed expressly to render the water non plumbo-solvent, and at the same time to remove any suspended peaty matter that may be in the reservoir water.

The neutralisation of the acidity and safeguarding of the water against action on lead is effected by passing the water through a layer of specially prepared and granulated magnesite; the acidity of the water dissolves the magnesite in proportion to the quantity of acid present, and so automatically regulates the neutralisation and hardening of the water.

The magnesite layer is contained in a special compartment in which hand holes are provided, so that granulated magnesite can be added from time to time to make up for that dissolved.

Previous to passing through the magnesite the reservoir water undergoes filtration through a sand bed contained in the upper part of the filter for the purpose of removing any suspended matter from the water.

The sand bed is provided with the Candy Filter Co.'s improved hydraulic sand-scour, by means of which the grains of sand are, during the cleansing process, violently agitated and

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caused to rub one against the other, thus obtaining perfect cleansing of the sand in a very short space of time, and with a reduced quantity of water; this scouring of the sand is effected by means of an arm provided with special hydraulic jets, and revolving slowly just above the surface of the sand, thus doing away with the serious objection to an arm revolving within the upper part of the body of the sand.

An upward flow of the water through the whole of the sand bed is employed at the same time as the hydraulic scour, so that all traces of solids retained by the bed can be eliminated in the washing process.

The layer of magnesite is provided with a similar cleaning arrangement to that of the sand bed, so that the granules of magnesite may be thoroughly cleansed when necessary.

It will be seen from this description that the Candy pressure filters employed are really duplex filters, and perform two functions, and are therefore necessarily somewhat different in construction to the other types of filters that are made by the Candy Filter Co. for removing impurities, such as bacteria, iron, and suspended matter generally.

The pipe line is of cast iron, 9 inches in diameter, and is just over 16 miles long. It has a minimum fall, to the highest service reservoir in Paignton, of 266 feet, and a stake head of 775 feet obtains at Holne Park.

Supplies are given to farms and Holne Park belonging to the Hon. Richard Dawson, also to Ipplepen, Teignmouth, and Brixham.

The Paignton Water Act, 1900, gave the Council power to supply water in bulk to outside authorities, and under that Act Teignmouth and Brixham Urban and Newton Abbot Rural District Councils are supplied.

The whole of the water is measured at Holne Moor by means of 8-inch Kennedy meters, in duplicate; and Venturi, Kent, and Siemens meters are used for measuring the bulk supplies.

Provision was made for scraping the main when it should be found necessary, and hatch boxes were put in on the line of main a quarter of a mile apart.

Owing to the large growth of Paignton in the past decade, *i.e.* 32 per cent., and to its growing popularity as a health resort, the Council last year decided to promote a Bill in Parliament to

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obtain powers to duplicate the trunk main. Severe opposition was experienced in both Houses of Parliament, chiefly as to additional compensation water, but the petitioners were unable to sustain their claim in this respect, and have to be content with the quantity of water given as compensation under the 1900 Act.

The estimated cost of the works under the 1911 Act is 27,500*l.*, and sixty years was granted as a loan period for the works. Royal assent was given to the Bill in August, and at any time the Paignton Council can proceed with the duplication of the main and the installation of a further six Candy filters.

There are three service reservoirs in Paignton—

High level	612	feet	above	O.D.	Capacity	600,000	gallons.
Mid	345	„	„	„	„	300,000	„
Low	182	„	„	„	„	11,000,000	„

Supplies can be drawn to the low-level district from the mid-level and the high-level reservoirs in case of fire.

During the prolonged drought of this year Paignton has enjoyed a constant supply of water, although the summer visitors have come in greater numbers than ever before.

DISCUSSION.

MR. T. MOULDING: I beg to propose a hearty vote of thanks to Mr. Hawkins for his description of the Moorland Water Supply of Paignton, and to Mr. Baines for his description of the Municipal Engineering Works of Paignton. I congratulate Mr. Baines on the lavatory which he has built. It is a very fine convenience indeed, and the glass roof seems to be quite the right thing, making its appearance cheerful and bright.

MR. H. A. GARRETT: I beg to second the vote of thanks to the writers of the papers. Paignton is to be congratulated on the bold step it has taken in connection with its water supply; because in a health resort like Paignton, it is important that you should have an abundant and pure water supply. You have got that now, and it is a very fine supply. Would Mr. Hawkins give the consumption per head per day which he has been supplying especially during the last summer? I see you have had no trouble in maintaining a constant supply of water; but

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you have had great difficulties with the construction of the works. You never can tell where you are going to find a fault in the granite subsoil and rock, and consequently I understand you had to spend a good deal more than was estimated to get to the foundation. You are not alone in that, because at Torquay we had a similar experience. We had to go down over 100 feet before a suitable foundation was found. I notice Paignton has got perilously near to the district I represent, in fact, the two districts are practically now connected. I do not know whether that is a hint of your intention to extend your tentacles, and absorb Torquay in Paignton. The time will probably come, and at no distant date, when the whole district, bounded by the shores of Torquay, will be under one central authority. I should like to ask whether you get any heavy traffic on the sea front. Tar spraying is one of the best palliatives of the dust nuisance, and Mr. Baines has carried out a good deal of this work in the best way, and got very good results. I should like to know whether the mixing of the crude with distilled tar is satisfactory, or is it only to make the material go further. I should also like to ask the steepest gradients on which he has been spraying his roads. Mr. Baines gives a very decided opinion that it is absolutely necessary to have a good and dry surface for tar spraying. I do not altogether agree with that. If you want the best results you must experiment in all kinds of weather. I tarred one of my roads with rectified tar in one of the heaviest showers of this year, and it is the best piece of road I have got. On the question of having an absolutely dry surface we need not trouble very much if we have properly distilled or rectified tar, of course I do not mean to lay the material in drenching weather, but ordinary autumn weather does not affect it very much. I intend to carry on the tarring of my roads as far as the weather will permit. May I ask if, to get the results set forth in the paper from the refuse destructors, any coal or other fuel was added to the refuse in its disposal? Have you made any pyrometrical tests as to the temperature of the gases at the base of the chimney? The melting of the copper bar in the furnace does not give us any real help as to the temperature of the gases emanating from the chimney.

MR. J. PATON: The papers deal with matters which are of great interest to Municipal Engineers. One cannot help being

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struck with the progressive character of the town, and the progressive spirit which actuates the local authority. They have spent an enormous sum of money upon the waterworks particularly, and they have set an excellent example to similar towns in this country in showing what ought to be done in order to safeguard a pure and constant supply of water. It is of the utmost importance to a place like Paignton, that it should have a thoroughly pure and reliable supply of water. Not only this, but the sanitary administration generally, as to the sewers, the removal and disposal of house refuse, and street cleansing, all those matters are of the utmost importance. The general cleanliness does strike one on coming into the town, and I believe that has much to do with inducing people who come casually to a place to come again. An exceedingly interesting part of this paper is with regard to the disposal of refuse. It shows what can be done in small towns by way of destroying refuse by a destructor. Fortunately you were able to make an arrangement with the Electric Lighting Company to take the waste heat for the purpose of producing steam. There have been many experiments in different parts of the country in that respect. We tried it in Plymouth, but we found that the refuse alone was so variable in its character that it could not be depended upon for its steam-raising qualities, and it had to be discontinued, notwithstanding that we had gone to considerable expense in laying down additional boilers, steam pipes, and the necessary fittings. It is of the utmost importance to small towns, or where you have small populations to deal with, that you should not take into consideration the calorific value of the refuse, and try to utilise it in the production of steam. The primary object of a destructor is to effectually and quickly destroy the refuse of a town, and I am quite sure a good deal of capital expenditure would be saved if this was done. We have heard all sorts of stories about gold in the dust bins. That may be all very well for journalists, but the local authorities who have to carry it through discover these statements are myths and fairy tales. The great trouble with most authorities who have destructors is the disposal of the residue. I was struck with the smallness of the residue, which is about 25 per cent. in Paignton. I never get anything like that result. The residue at Plymouth works out at a little over 30 per cent. That includes tins and hardware, and things of that kind.

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MR. BAINES: Tins are not taken in as a residue here.

MR. PATON: That will make a difference. Although there is a limited market for tins and old metal, it hardly pays for handling. That is a serious matter, as it costs something like 9*d.* per ton to cart it away from the tip. At Paignton you pay for the clinker and no doubt you have some use for it which makes it worth the amount. In that respect you are exceedingly fortunate. When I was last in Paignton I was particularly struck with the tar spraying of the roads; they seemed to be well done and quite a success. I have gone in for that to some extent, but I must say that some of it has not been a success. It is probable that I have not got the right tar or the right mixture. I have used refined tar, and other preparations of tar, but I find during certain weather the surface disintegrates and breaks up, and there is a nasty black mud on the surface of the roads. That may be caused by the fact that the right material is not being used. The cost of this tar spraying seems to be exceedingly low. Personally I cannot get it anywhere near that figure. It is something like 1½*d.* per yard, including sanding.

THE PRESIDENT: I should like to congratulate the town of Paignton on its progressive policy. There is no doubt, as our past President, Mr. Paton, has said, towns of this character depend very largely upon their visitors, and they should, to the very best of their ability, cater for them. Paignton is very fortunate in being able to dispose of its sewage in such an easy manner as it does. Those of us who live in manufacturing towns have to spend a great deal of money in dealing with the sewage, and know what a difficult problem it is to contend with. As regards the disposal of house refuse, Paignton is an example of what towns should endeavour to imitate, many large towns would be very glad if they could get rid of their house refuse in the same way as you do in Paignton. I find on inquiry you have no privies and night soil to deal with as we have in the older towns. In my own town, two years ago, we had 4000 of these abominable privies to deal with. I am pleased to have had the opportunity of visiting the town of Paignton during my year of office, and I congratulate not only the town, but Mr. Baines on the way the work has been carried out. I have pleasure in putting the resolution proposed by Mr. Moulding, and seconded by Mr. Garrett, to give a vote of thanks to the authors of these papers.

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The vote having been carried with acclamation,

MR. C. O. BAINES, in reply, said: I thank you very much indeed for the kind way in which you have expressed your thanks to me for the paper. It has been a real pleasure to me to see you all here to-day, and I hope the weather will hold fine so that we shall have a good time. I will answer Mr. Garrett's questions shortly. With regard to the tar-granix road, that was a happy hunting-ground for traction engines and motor lorries for a period, until we discouraged them, and now the motors have a good time instead. With regard to the mixture of crude and distilled tar, we have tried several degrees of mixture of these two materials. Mr. Garrett says he has had a good result from tarring a road on a wet surface. I am very glad to hear it, but I must say I have utterly failed to get such a result. You have only to go outside this Town Hall to the electric palace, and you will see there the result of a little experiment I tried on a wet surface. You may go in the opposite direction; that road was done last April with distilled tar, on a dry surface, and it is as good as the day it was done. Within fifty yards of this room you have the examples. With regard to the use of crude tar by itself I must say it is not anything like so good as distilled tar. It causes no end of worry and expense in the long run. Although crude tar will cover twice as much of road surface as distilled tar, you have to do it over again, probably two or three times during the season. We pay $2\frac{3}{4}d.$ per gallon for crude tar; and get distilled tar for $3\frac{1}{4}d.$ per gallon from Plymouth, and exceedingly good tar it is. I have found the most satisfactory result from every point of view in using the distilled tar alone. I can show you a road treated with crude tar, and you can hardly see anything of it, although it was done three months after the road which was treated with distilled tar. I think this proves the case for distilled tar against crude tar. As to the gradient on which we can tar spray, we have not put the tar on a road of more than 1 in 13. Even then I think it is too sharp a gradient, because if you get a little rain it becomes slippery. With regard to the destructor, no fuel is used, except some coal to start the fire. The fires are damped down at the end of the week, and coal is used to start the fire again. In our refuse we get a large amount of inflammable material in the shape of cardboard and paper, so it is not necessary to use more fuel than to start the fire. Our refuse does not vary very much. It is only a question of being wet or dry. If

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it is wet we have more trouble with it, but nothing extraordinary. With regard to temperature we have not made more than one pyrometric test. The residue of 25 per cent. does not include tins. The character of our refuse is purely domestic. We have no manufactures of any kind here, so we cannot expect a very hard clinker. We use the clinker on the footpaths, for tar macadam paths and concrete.

MR. J. C. HAWKINS: It has been a pleasure to me to write this paper, and I hope it has been written sufficiently clearly for you to understand the works which have been carried out. I have described the works as I found them, the whole credit for the construction is due to Mr. Vanstone and his son. I think they will be coming with us to-day, and those who want any special information on the design of the undertaking, will do well to keep close to them. The consumption per head per day is 26·7 gallons, which I think is remarkably low for a health resort. We have so many large gardens here that we find great difficulty in keeping it down to that quantity, but we have spared no trouble in trying to locate the waste water, and immediate steps have been taken to stop the waste after leaks have been found. The inspections have been made throughout the district regularly and the consumption of 26·7 gallons per head is about as low as we can expect to get it. I am very pleased to have been able to do anything to contribute to the success of this meeting.

The vote of thanks was unanimously accorded.

The Members then proceeded by motor 'bus to the pipe works of Messrs. Hexter Hempherson at Newton Abbot, where the processes of manufacture and the testing of pipes were seen.

The Members were entertained to luncheon at Newton Abbot by the kind invitation of the Chairman and Members of the Paignton District Council and Mr. C. O. Baines.

After luncheon the Members proceeded by motor 'bus to the Paignton Waterworks on Dartmoor. At the works they had an opportunity of inspecting the Candy filter installation in process of building and extension. The route to the works was by way of Chudleigh Knighton, Ashburton, and Holne Bridge, and the return journey was made by way of Buckfastleigh and Totnes.

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METROPOLITAN DISTRICT MEETING.

October 21, 1911.

Held at Battersea.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Members assembled at the Town Hall, where they were received by the Mayor (Mr. J. E. Astill, J.P.), the Town Clerk and the Borough Engineer.

The Mayor very cordially welcomed the Members of the Institution to Battersea.

The President on behalf of the Members thanked the Mayor for his kindly welcome, and referred to the meeting at Battersea when the Right Hon. John Burns, President of the Local Government Board, delivered a most interesting address.

Mr. Norman Scorgie was unanimously re-elected Hon. Secretary for the Metropolitan District.

NOTES ON THE CONSTRUCTION OF THE NEW MAIN LOW LEVEL SEWER FOR THE SOUTH SIDE OF LONDON, FROM BATTERSEA TO DEPTFORD.

BY R. M. GLOYNE, M.INST.C.E., *Member*, DISTRICT ENGINEER, L.C.C.

THIS sewer forms part of the great scheme for increasing the drainage facilities of London, which is being carried out by the London County Council, on the advice, and under the direction, of the Chief Engineer, Maurice Fitzmaurice, Esq., C.M.G., M.I.C.E.

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It passes through the boroughs of Battersea, Wandsworth, Lambeth, Camberwell, and Deptford, under Deptford Creek to the Deptford pumping-station, where the sewage will be pumped into the low level outfall sewers which convey sewage to the Crossness Outfall Station.

A short length of this new sewer was constructed some five years ago, and is at present acting as a storm relief for the Wandle sewer in South Street, Wandsworth, by conveying storm waters, *viâ* North Side Wandsworth Common and Vardon's Road, Battersea, to the Falcon Brook pumping-station in York Road, Battersea.

The new works commence in the Borough of Battersea at the west side of the London and South-Western Railway at the junction of North Side Wandsworth Common with Vardon's Road, by a connection with the sewer mentioned in the previous paragraph, so that in future the portion of existing storm relief sewer, between this point and South Street, Wandsworth, will become part of the main sewer, and the length from Vardon's Road to the Falcon Brook pumping-station in York Road, Battersea, will constitute the storm relief.

The sewer now being constructed is, including connecting sewers, about 8 miles in length, varies in diameter from 6 feet to 8 feet, and is built, partly in brickwork, and partly in cast-iron rings, lined with blue bricks and concrete, practically the whole length being tunnelled at depths from the surface to invert level varying from about 22′ 0″ to about 70′ 0″. The gradients of the main sewer are 1 in 1851 and 1 in 2640.

The brickwork portion, about 15,950 feet in length, consists of two rings of wire-cut rough red bricks, and one ring of pressed bricks, the lower half of the inner ring being of pressed blue, and the upper half of pressed red bricks.

This work was tunnelled through the London clay, from shafts sunk at intervals by the usual method of short headings in advance of the length, afterwards enlarged to the proper diameter.

The working shafts on the brickwork portion of the main sewer were excavated and timbered in the usual manner, and were later on converted into permanent manholes or side entrances.

The timbering of the lengths, which measured 7 feet 6 inches, consisted of 7-inch diameter larch bars, and 1¼-inch

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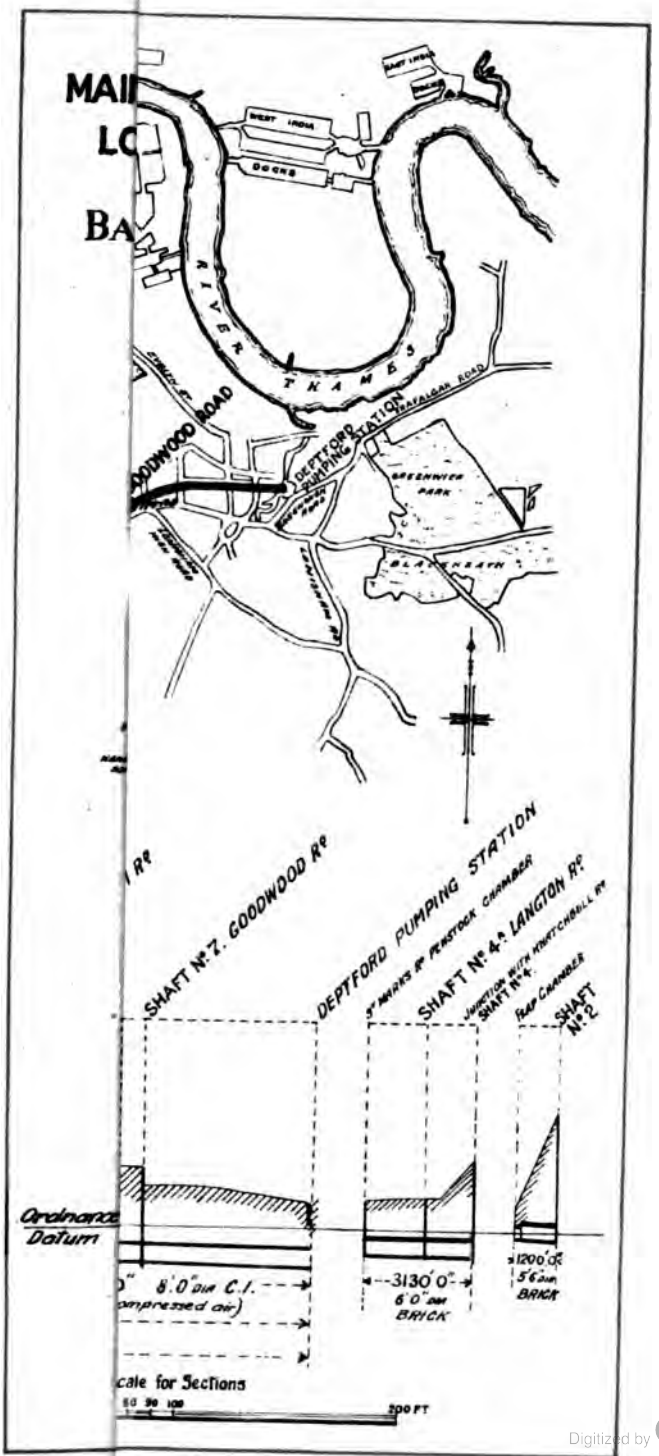

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poling boards, with the necessary sills, props, etc. All bars were removed, and the space between the back of the outside ring of the sewer and the poling boards, where these were left in, or the clay, where the boards were removed, was packed solid with brickwork in cement.

The rate of progress on the brickwork sewer was excellent, one length per day per face, or 90 feet per week at each pit being regularly built week after week.

There are three connections to this part of the new sewer, in addition to the one with the sewer built some five years ago at Windmill Road, Battersea, viz. one left for future extension southwards into Wandsworth; one with the Falcon Brook sewer at St. John's Road, Battersea; and one at Fontarabia Road, Battersea, by means of a connecting sewer with the Heathwall sewer at Wickersley Road, Battersea. At frequent intervals side entrances or manholes have been constructed to provide for access to the sewer.

The ironwork portion of the sewer, about 26,200 feet long, consists of cast-iron rings $\frac{7}{8}$-inch thick, lined with fine concrete, the invert and up to springing being of pressed blue bricks; each ring is made up of six segments and a key piece with internal flanges 6 inches deep by $1\frac{1}{4}$ inch thick, and $\frac{7}{8}$-inch stiffeners, and measures 21 inches in length. The rings vary in external diameter from 9 feet 4 inches to 9 feet 10 inches, and form a completed sewer when lined of 7 feet 6 inches and 8 feet diameter respectively. The greater part of this length is constructed with the help of shields, through water-bearing gravel and sand, and under compressed air. The working shafts on the ironwork portion are of cast-iron cylinders, 20 feet and 16 feet 11 inches in external diameter, made up of rings 4 feet in depth, each ring consisting of twelve segments. The bottom ring of all was furnished with a cutting edge, and the method of sinking was to erect the cutting edge ring, after excavating for a few feet from ground level, and then by continually excavating from inside the shaft and adding fresh rings to sink the shaft to water level. On getting down to water level an air-tight iron floor was fixed in the shaft with an air lock, and further excavation proceeded with under compressed air. The necessary air compressing plant is installed at three of the working shafts, and comprises the following, viz.:—

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At Knatchbull Road, Camberwell.

Two high-pressure and six low-pressure machines by Reavell and Co., Ipswich, all driven by two-phase motors. The high-pressure machines have four cylinders, each 8 inches diameter by 7-inch stroke, and run at a speed of 280 revolutions per minute, maintaining an air pressure of 80 lbs. per square inch in the receiver to feed the grouting machine, and intensifier for working the shield. They are belt driven and are fitted with automatic belt-shifting device and all usual fittings.

The six low-pressure machines each have four cylinders, 13 inches diameter by 6 inches stroke. Two of these machines are fitted with hand unloading valves on three of the cylinders to enable one or more to be cut out if required. They all run at a speed of three hundred revolutions per minute, and are capable of compressing a total quantity of 3000 cubic feet of free air per minute to a pressure of 15 lbs. per square inch.

At Sedgmoor Place, Camberwell.

This station consists of two high-pressure machines and six low-pressure, the design and dimensions of which are exactly similar to those at Knatchbull Road, except that in these machines there is no unloading device, the quantity of air delivered being regulated by the speed of the motors which are of the continuous current variable speed type.

At Goodwood Road, Deptford.

This station consists also of two high-pressure machines and six low-pressure, and is an exact repetition of the station at Knatchbull Road, with the exception that the six low-pressure machines are fitted with Reavell special friction clutches, and all are driven from single-phase motors.

In addition to the above, this station has an Ingersoll-Rand compressor, capable of compressing 2637 cubic feet of free air per minute, to a pressure of 15 lbs. per square inch. Each plant is fitted with two pairs of after coolers for cooling the air before it is supplied to the tunnels.

The shields were constructed by Markham & Co., of Chesterfield, and are 1 inch larger in diameter than the outside diameter

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of the cast-iron rings. They are pushed forward by hydraulic pressure acting on any, or all, of the eight rams, 7 inches in diameter, with which each is fitted. By this individual control of each ram, corrections can be made, if necessary, in either line or level, and the shield driven accurately round curves. The pressure is obtained by taking water from the ordinary water mains in the streets and leading it to a Hayward-Tyler air-driven hydraulic pump mounted on a tank on wheels, which is drawn ahead by the shield as it advances. The air cylinder of this pump is double-acting and 7 inches in diameter, the ends of the 1-inch piston rod forming the plungers for the hydraulic force pumps. The air is admitted to the air cylinder at about 60 lbs. per square inch, the hydraulic pressure being transmitted from the force pump to the shield rams at about 2940 lbs. per square inch. When all the rams are working the pressure exerted is over 400 tons.

The method of working in the water-bearing sand and ballast is as follows:—The face of the tunnel is well covered with pug, close boarded and strutted, to prevent falls of the soil, and, as far as possible, the escape of the compressed air; and portion of the ballast and sand opposite and all round the cutting edge of the shield is taken out in pockets to a depth of some 24 inches and extending to about 3 inches outside the circumference of the cutting edge of the shield, the pockets being filled in with clay, well rammed in, so that the cutting edge, when the shield is driven forward, penetrates the clay, a "blanket" of which is left over the shield as the latter moves forward, thus preventing, to a great extent, any escape of air at the tail of the shield.

The hydraulic rams which actuate the shield bear against wood packing placed between them and the last cast-iron ring erected, and push the shield forward into the face sufficiently far to enable one ring to be put in under cover of the shield. Before this ring is put in, however, the previously erected one is "grouted up," the annular space between the outside of the iron and the ground surrounding it being filled with liquid lime grout forced in, under a pressure of about 60 lbs. to the square inch, through the holes left in the cast-iron ring segments for that purpose. For grouting, each ring requires about 2½ bags of lime. The hydraulic rams are then drawn into their cylinders and the next ring erected. This being done, the face of the tunnel is once more attacked, the horizontal face boards

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being taken down two at a time, and, on the ground being excavated, put into their fresh position 21 inches further ahead, and temporarily strutted from the shield until such time as the whole of the face is advanced, when "soldiers" are erected, bearing against all the face boards, and strutted back to a completed tunnel ring, the temporary struts being then knocked out and the shield pushed forward once more over the timber face.

Up to the present time the air pressure required has not been more than from 5 to 6 lbs., but while passing under Deptford Creek, which is subject to the influence of the tide, a considerably greater pressure will no doubt be required. At high water there will be a difference between the water level in the Creek and the invert of the sewer of about 30′ 6″.

The progress in this part of the work is also excellent, an average of from six to seven rings being erected in 24 hours at each face. To ensure water-tightness the flanges of all segments are machined except for a space 1 inch in depth on the inside where the iron is $\frac{1}{8}$-inch less in thickness than the flange. When two segments are bolted together there is therefore a space 1 inch deep by $\frac{1}{4}$ inch wide, forming a groove which is caulked with lead wire and with iron filings and sal ammoniac, the latter making an efficient rust joint. The bolt holes are made water-tight by yarn grummets well soaked in red lead, which are squeezed into them under the iron washers placed on the bolts at each end, while the grout holes, besides being sealed by the grout, are furnished with yarn grummets and screw plugs.

The whole of the plant at these shafts is worked electrically, the materials being handled on the surface and lowered down the pits by 3-ton electric locomotive cranes, and hauled along the tunnels by an 8-h.p. electric locomotive.

The tunnels are lighted by electric light, and telephonic communication is available between the men working in the compressed air and those at the shafts outside the air-lock.

On the ironwork length there are eight connections; one at Knatchbull Road, Camberwell, from which a new sewer has been constructed to join the existing low level at St. Mark's Road, Lambeth; one at Camberwell Road with the existing Earl sewer; one at Southampton Street with a local sewer; two at Asylum Road, Camberwell (one with the White Post Lane main, and one with a local, sewer); one at Kender Street,

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Deptford, with the existing main low-level sewer; and one at Amersham Vale, Deptford, also with the main low-level sewer, while an "eye" has been left at Jeffrys Road, Lambeth, for a future connection with the Heathwall sewer.

Large cast-iron penstocks and timber dams are provided at all the main connections so that the flow of sewage can be controlled in either the existing or new sewers.

The penstocks are provided and fixed under a separate contract with Messrs. Markham & Co., and all the other work is being carried out by Messrs. Griffiths & Co., contractors, of London Wall, the value of their accepted estimate being 481,553*l.* 9*s.* 11*d.*

The amount of brickwork used in the brickwork portion of the sewers, including side entrances, etc., is about 27,400 cubic yds., and the weight of cast iron in the C.I. portion, including penstock chambers, etc., is approximately 22,150 tons.

Work was commenced in January, 1910, the time limit being three years.

The Author, as District Engineer, is in charge of the work, under the direction of the Chief Engineer, and Mr. J. P. Harris is the Resident Engineer.

DISCUSSION.

Mr. T. W. A. Hayward: It gives me pleasure to move a vote of thanks to Mr. Gloyne for the excellent paper he has prepared and presented to us. The London County Council always do their work as well as it is possible to do it, and the question of cost is a secondary consideration. This new main sewer is a very fine piece of work. It runs through the whole length of Battersea, west to east, and on to Deptford. I have been on the works a great deal and can testify that the work is done in the best possible manner. I would like to express my appreciation of the services rendered by Mr. J. P. Harris, the resident engineer, in arranging this meeting. When one considers the magnitude of the work—the contract price being about half a million sterling—it gives some idea of the amount of responsibility involved. Even the preliminary work, before starting on the sewer proper, is something to be proud of; I refer to the design of the airlock. I imagine that this will be of particular interest to Members, and I am glad

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to see so many in attendance here to-day. Battersea has been troubled with storm-water flooding for a great number of years, and the work of preventing such flooding carried out by the London County Council and their predecessors has been progressive. The first pumping station was erected in the early eighties, but this was soon superseded by a new and larger one, which was connected with the then largest main sewer. Some six or seven years ago an additional relief sewer was laid in Battersea by the London County Council and an additional pumping station erected, which Members will find fully described in a paper read at the district meeting held in Battersea in May, 1906. The present sewer is designed to relieve flooding still further, and it is hoped that when this sewer is in working order the borough of Battersea, as well as its surrounding districts, will be entirely relieved of the ill effects of flooding. It is with pleasure that I move the vote of thanks to Mr. Gloyne, and to Mr. Fitzmaurice, the chief engineer, who has so kindly placed the drawings at the disposal of this meeting for the inspection of Members, and also kindly given his consent for the Members to visit the works.

MR. A. E. COLLINS: I have very great pleasure in seconding the vote of thanks to Mr. Gloyne. It happened that I presided over the meeting here in 1906, when the President of the Local Government Board took part in the proceedings. The second reason why I have pleasure in seconding this vote is that Mr. Gloyne and myself were associated a quarter of a century ago in municipal work, and I have always had the most pleasant recollections of him. This work Mr. Gloyne is doing is of very great interest to all of us. Referring to the sewers constructed within cast-iron rings, with internal diameter kept constant, does Mr. Gloyne consider there is any objection to the internal lining being of hard tiles of say 1 inch to 1½ inch thick instead of brickwork 4½ inches thick? A considerable saving in excavation, cast-iron rings, and concrete lining would arise from the use of such tiles instead of bricks. Does Mr. Gloyne consider machining of the ring joints to be advantageous as compared with having them fine cast and making the joints with strips of creosoted soft wood, as I believe has been done almost if not entirely throughout the Tube Railways? I can imagine difficulties in getting the machined joints to fit accurately everywhere.

The vote of thanks was unanimously accorded.

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MR. R. M. GLOYNE, in reply, said: I have to thank you indeed most heartily for the cordial vote of thanks you have given to me, and I am sure if Mr. Fitzmaurice were here he would also express his appreciation of the kindness by which you have passed the vote of thanks to him for the loan of the drawings and permission to view the works this afternoon. I shall be very happy indeed to reply to any points which may be raised, either on the works this afternoon or in writing afterwards. If Members who wish to raise such points will kindly write to me I will endeavour to give them answers. Although I am particularly busy I have had great pleasure in preparing this short paper, and I hope it will be of benefit to everybody this afternoon, if not an instruction. I am very glad indeed to have been able to be present at one of these meetings. It is many years since I attended one, I am sorry to say, but one is so busy in the service of the London County Council, that time does not permit of leaving one's office to attend.

The objection to lining the cast-iron sewers with tiles is that when cleansing operations become necessary, tiles would get broken and become displaced. I consider blue bricks much preferable.

As regards the machining of the segments, there is no difficulty in obtaining an accurate fit between the machined faces.

Each segment is inspected at the foundry both before and after machining, and stamped with a distinguishing mark.

Creosoted soft wood would rot in process of time, and it is not desirable to have any chance of leakage into the sewer. I consider a better job is made with the machined joints.

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SPECIAL GENERAL MEETING.

October 21, 1911.

Held at the Town Hall, Battersea.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Secretary read the notice convening the meeting. The several resolutions passed at the Special General Meeting, held at Gidea Park, on September 23, 1911, were put and confirmed unanimously.

MR. R. J. THOMAS, Aylesbury, Vice-President, moved a vote of thanks to the Mayor and Corporation of Battersea for the use of the Town Hall for the meeting, and it was unanimously adopted.

The Members then proceeded to inspect the sewer works in progress in Knatchbull Road, Camberwell, the Members entering the airlock and inspecting the works.

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SPECIAL GENERAL MEETING.

January 13, 1912.

Held at the Offices of the Institution.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Secretary read the notice convening the meeting. The following resolutions were carried unanimously:—

(1) That the Special Resolutions of the Institution passed on the 5th day of July, 1911, and confirmed on the 29th day of July, 1911, and the Special Resolutions of the Institution passed on the 23rd day of September, 1911, and confirmed on the 21st day of October, 1911, be rescinded so far (only) as they relate to alterations in the Memorandum of Association of the Institution.

(2) That Clause 3 (the Objects clause) of the original Memorandum of Association be altered as shown on pages 3 and 4 hereof.*

(3) That the necessary application be made to the Court for the confirmation of the alterations specified in Resolution 2.

* *The alterations were set out in full in the notice of the meeting.*

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METROPOLITAN DISTRICT MEETING.

February 9, 1912.

Held at the Caxton Hall, Westminster, S. W.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE minutes of the previous meeting were read, confirmed, and signed.

THE RELATION OF MODERN ROAD SURFACINGS TO FISH LIFE.

BY W. J. A. BUTTERFIELD, M.A., F.I.C., ASSOC.INST.C.E.

QUESTIONS have frequently arisen of late in regard to the effect of surface washings from roads on the fish life in the streams, ponds, or rivers into which the washings ultimately pass. The materials used in the construction and maintenance of roads, and their methods of employment, have changed in most districts in recent years, while, where the old methods of maintenance have been retained, various compositions have been applied to the surface of the roads with a view to suppressing dust in dry weather. It has been frequently alleged that the new methods and materials have resulted in pollution of the surface washings of a nature which has been responsible for the death of fish in adjacent waters into which the washings have passed. Opinions as to the fairness of these allegations have been expressed with a partiality and an assurance worthy of firmer foundations. The ascertained facts, as to the effects of different road surfacings on the composition of the washings and of the effects of the latter on fish life, have hitherto been very few. The object of the investigations, described in this paper, has been to collect more

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definite data, on which it will be possible for those interested in road construction and maintenance, as well as all who are interested in saving water-courses from pollution, and in preserving fish life in rivers and lakes, to form a judgment which will have a trustworthy basis. It will, doubtless, be necessary from time to time to enlarge our knowledge in this respect by further investigation in a like direction, but the results reported in this paper should suffice to enable fairly reliable deductions to be drawn in regard to the effect on fish life of the materials which are used for road treatment at the present day.

1. The Water-bound Macadam Road.

The road surfaces primarily considered are those of the main and secondary country roads, to the exclusion of street paving such as is employed solely in towns, because only in a few cases will the latter, for obvious reasons, have any very direct bearing on the pollution of fishing streams. The main and secondary country roads were, until about five years ago, with very few exceptions, constructed of water-bound macadam; the stone used varying according to the locality, and the nature and volume of the traffic. The disintegrated stone or earth used as binding material would not, on extraction by water, impart to the latter ingredients differing appreciably from those of water draining from soil in the vicinity. Hence, the materials used on water-bound macadam roads may be regarded as having in themselves no specially pernicious effect on water-courses into which the surface washings from the roads might pass. The only question which arises in connection with such roads is the effect of refuse (e.g. horse-droppings, petrol, lubricating oil) dropped on the roads by passing traffic, and as this question arises with even greater force in the case of roads constructed or surfaced with more impervious materials, it will be discussed after these materials have been considered.

2. Dust-abating Materials: *Sea water, calcium chloride.*

The advent of self-propelled vehicles on the road, which followed the passing of the Motor Car Act in 1896, caused attention to be drawn to the dust-making qualities of different road surfacings. The higher speed at which vehicles of the

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same weight were able to travel after self-propulsion became permissible, was attended by a greater formation of dust and a wider dispersion of that dust through the air. In order to reduce the formation of dust and to make the dust formed less liable to be widely dispersed through the action of passing traffic, various agents have been applied to the road surface. Certain of these agents, which are independent in their action of the state of humidity of the atmosphere, can be more appropriately dealt with under a subsequent heading, but there are others which depend for the permanence and effectiveness of their action on the variations in the degree of humidity of the atmosphere. First, there is the time-honoured expedient of road-watering which, obviously, is inapplicable to country roads where supplies of water are not always obtainable at frequent and regular intervals, and where the cost of frequent and regular watering must be prohibitive. The duration of the effect of road watering is determined solely by the rate at which evaporation proceeds, and once the water has been disseminated as vapour in the atmosphere the effect of the watering will have passed away. In order to obtain a more lasting effect, it was proposed, in the early stages of the dust-abating movement, to use salt water for road-watering in place of fresh water. On evaporation, the former leaves a residue of sodium chloride (common salt) and other salts, the bulk of which are hygroscopic. That is to say, these salts absorb moisture from the air when it is relatively humid and give up moisture to the air when it is relatively dry. In the semi-liquid state which they attain, unless exposed to a dry atmosphere for a sufficiently long time, these salts permeate the more porous particles of disintegrated road material, thus rendering them comparatively heavy and hindering their subdivision into finer particles. The relatively large and heavy particles which then constitute the dust are less easily raised by passing traffic, and if raised, settle more readily. Hence, the dust nuisance is appreciably abated by the employment of such hygroscopic salts. The first solution of salts thus employed for dust-abating purposes, viz. sea water (which, for reasons which it is alien to the purpose of this paper to discuss, was generally discarded after trial), has no appreciable significance in regard to its effect on fish life, because the majority of our fresh-water fish are not forthwith seriously perturbed by a transference from fresh water to sea water or to

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a mixture of fresh and sea water. Many, indeed, of those which are most highly esteemed by the angler are migrants. More effective than sea water, in that its action is more lasting and its subsidiary effects less objectionable, is a solution of calcium chloride, a salt which chemically closely resembles sodium chloride, which is the chief saline constituent of sea water. This salt, when dissolved in water in the proportion of one part of calcium chloride to 1000 parts of water, has no effect on fish (gudgeon). Since the rate of extraction of calcium chloride from road surfaces, to which it has been applied, is extremely unlikely to produce a solution of it of as high a degree of concentration as that named (see the Reports of the Judges' Committee of the Roads Improvement Association on the Official Tests of the Dust-laying Qualities of Calcium Chloride, 1909–10), it may be inferred that calcium chloride may be applied to roads for dust abatement without risk of ill effects on fish life in the streams and ponds of the district.

3. Bituminous or Tarred Surfacings.

The application of tar and bituminous materials to country roads was initiated with a view simply to abating dust. Among the early materials of an oily or bituminous character which were tried were preparations of petroleum and blast furnace tar, but the application of these materials has since passed into relative insignificance compared with the use of coal tar, and latterly of certain natural bitumens and asphalts. Originally the intention underlying the employment of coal tar, other tars, and oils, etc., was to bind the particles constituting the road-surface together by a semi-plastic and essentially non-brittle material, and, in the event of the particles being torn asunder, to have their pores so filled by a heavy liquid or semi-solid that they would remain in suspension in the air only for a very brief time. The employment of these materials with this object resulted, however, in the discovery that they serve another purpose, which is of far greater ultimate importance, viz. that of prolonging the life of the road surface and thereby, *cæteris paribus*, reducing the charges for road maintenance. It may now quite properly be said that tar and similar materials are applied to road surfaces primarily with the object of maintaining the road, and that the advantage of dust abatement which

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they afford is only incidental to their employment for maintenance. The surfacing of roads with tar and similar materials, if properly carried out, results in the outer layer or skin of the road being rendered waterproof, and so long as this skin remains intact, water cannot penetrate to the underlying road material. The extent to which the tar which is applied for the coating or painting of road surfaces penetrates below the surface depends on a number of factors, among which may be named the nature of the road material, its degree of consolidation, and the viscosity of the tar on application. To whatever extent the penetration of the tar may vary according to the varying conditions of its use, it is only the surface layer or skin of the coating of tar which can affect water which falls or stands upon it, because, so long as the coating is sound, the water is prevented from penetrating the surface layer. On this account the quantity of tar applied to a road surface is less material in regard to the pollution of water-courses than is the extent of surface covered by the tar. The ultimate dispersion of the whole quantity of tar by attrition will in any case be spread over so long a period that it is unnecessary to regard it as having any serious bearing on the pollution of water-courses. The question therefore to be considered is to what extent water impinging with the force of the heaviest rainfall on a tarred surface, or water standing on such a surface (from which it may happen not to drain away quickly) may become polluted by such contact with the tarred surface. The effect of impingement of heavy rain is difficult to estimate; it is conceivable that in warm weather the drops of rain may momentarily pit the surface and so secure a larger area of contact than would otherwise be the case. But, on the other hand, such pitting of the surface can only occur when the rainfall is exceptionally heavy, and in that case the water will drain off from the surface more quickly, and the time of contact will be correspondingly short. Probably the most serious risks of pollution of water occur during a drizzle or long-continued rainfall, which at no time is heavy, as in that case the water will remain for a comparatively long period in contact with the tarred surface before draining from it into water-courses. These considerations apply to normal conditions. Cases may, however, occur, in which a heavy storm, with a rush of flood water, following very shortly after tar has been applied to a road, will be attended

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by the actual lifting away and removal of the tar itself while it is still soft and not consolidated with the road material. In that case the tar may be carried bodily into water-courses, and the question of the extent to which it will pollute the water therein has to be considered. The degree of pollution will be determined by the proportion of the tar so carried into the water-course to the total volume of water therein, and by the extent to which the tar and water are agitated together by the natural movement of the water. Such removal of the tar *en bloc* into water-courses can occur only in rare instances, but the probable effects of its occurrence on fish life will be considered later. Tar only has been spoken of in this paragraph, but the same considerations apply equally to bituminous surfacing materials in general.

4. Pitch and Asphalt-Macadam.

A few words may be said as to the possible effect of pitch or asphalt-macadam roads or pitch-grouted roads, as distinguished from water-bound macadam roads surfaced with tar or bituminous material. If the pitch-macadam or pitch-grouted road is properly constructed, water will not penetrate beyond the depth of surface inequalities; and for the present purpose it is sufficient to regard only the surface layer of such roads, and to bear in mind the difference in composition between the pitch, pitch-grouting or asphalt, and the tar or more fluid bitumen which is used for the surface treatment of water-bound macadam roads. The quantity of pitch used in constructing a pitch-bound road is not material for the case under consideration; it is only the area of surface, including inequalities, exposed, which comes into question in respect of the possible pollution of washings from the road. The possibility of pitch-bound macadam being carried bodily into water-courses is so remote that it need not be further considered.

5. The Nature and Composition of Tar and Pitch: *Coal Tar, Oil Tar or Water Gas Tar, Blast-furnace Tar, Producer Tar.*

The nature and composition of tar and pitch need only be considered in so far as they have any bearing on the question of the possible pollution of water which has been in contact

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with the tar or pitch, but since the effect of these materials on water varies very greatly with their nature and composition, it is necessary to indicate, broadly, the differences in tars and pitches ordinarily produced in this country.

Coal Tar is a by-product of the carbonisation of coal on gas-works and in coke-ovens. Its nature and composition vary widely according to the heat to which the coal has been raised in the course of carbonisation, and according to the disposition and size of the carbonising chamber or retort. The specific gravity may range from 1·12 to 1·29, being higher the higher the temperature to which the tarry vapours have been exposed, and the longer their exposure thereto in the carbonising plant. In all cases the crude tar, as produced, contains: a certain amount of water or aqueous liquor, containing more or less ammonia and salts of ammonia; a small proportion of light oils; a larger proportion of middle or creosote oils, frequently containing a considerable quantity of naphthalene; a rather smaller proportion of heavy oils, from which anthracene may be extracted; and a large proportion of pitch, which consists mostly of bituminous matter, but contains a varying proportion of uncombined carbon. The extent to which these ingredients vary may be roughly indicated:

Crude coal tar may contain from about 1 to 30 per cent. or more of water or ammoniacal liquor. The percentage of water depends on the efficiency of the plant used for the separation of the tar and liquor at the gasworks, but is largely influenced by the nature of the tar. Tar produced at high heats of carbonisation and with a considerable free space in the retorts will contain a large proportion of water which the separating plant will ordinarily abstract with great difficulty, owing to the water and tar being in an emulsified condition. The water may in all cases be removed from the tar by distillation or boiling, but in the case of tars produced at high heats and containing a large proportion of water, its removal by boiling or distillation becomes troublesome owing to the frothing and violent bumping which ensue when such tars are boiled. It can only be properly carried out under skilled supervision in the special stills which are provided in tar works. The composition of the liquor will be referred to subsequently.

The light oils in coal tar comprise the oily constituents which distil over with the water and up to a temperature of

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170 deg. C. They vary in amount, according to the source and character of the coal tar, from 1 per cent. to about 5 per cent. They have a lower specific gravity than water, and as their components are practically insoluble in water, they float on the surface of the latter, and are chiefly responsible for the surface film which is generally formed when crude tar is mixed with water.

The proportion of middle or creosote oils, distilling between 170–270 deg. C., varies, according to the source and character of the coal tar, from about 9 per cent. to 25 per cent. They have a higher specific gravity than water, and ordinarily hold in solution considerable quantities of phenols or tar acids and naphthalene. The proportion of crude tar acids naturally present in the oils may vary from about 1 per cent. to 25 per cent. by volume of the oil, being usually greater when the tar vapours have not been exposed to a high temperature in the carbonising plant. The amount of naphthalene generally present in the middle oils is greater than they can hold in solution at ordinary temperatures, and consequently these oils contain more or less naphthalene in a solid state. In many cases, they are a pasty or almost solid mass, owing to the large proportion of naphthalene they contain, and the oil proper can only be obtained by expression. The proportion of naphthalene is larger the higher the temperature to which the tarry vapours have been exposed and the longer their exposure thereto in the carbonising plant.

The amount of heavy oils distilling above 270 deg. C. varies from about 2 per cent. to 15 per cent. of the tar according to the source and character of the latter, and the temperature at which its distillation has been stopped. These oils are generally pasty at ordinary temperatures, owing to anthracene and allied bodies being deposited from them on cooling.

The proportion of pitch, which is the residue remaining in the still after the greater part of the volatile oils have been driven off, varies, according to the source and character of the tar and the temperature at which the distillation of the tar has been stopped, from 50 per cent. to 85 per cent. of the tar. The pitch is a solid, more or less plastic, or more or less brittle, according to the amounts of heavy oils which have been allowed to remain in it as determined by the temperature at which the distillation of the tar has been stopped. The main constituent of the pitch is bituminous matter of a complex nature, but there

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is in the pitch also, a certain proportion of "free" carbon which varies, according to the conditions of formation of the tar, from 10 per cent. to 35 per cent. of the pitch, being greater the higher the temperature to which the tarry vapours have been exposed and the longer their exposure thereto in the carbonising plant.

Oil tar proper, or the tar, frequently termed either "oil tar" or *water gas tar*, which is derived from carburetted water gas plant has a specific gravity generally rather higher than that of water, though occasionally samples are found of a lower specific gravity. The carburetted water gas tar in its crude state consists of an emulsion of tar and water in which the proportion of water is often very high. Separation of the water is frequently attended with considerable difficulty. The water contains little or no ammonia. The proportion of light oils in the crude tar varies from 5 per cent. to 25 per cent.; of middle oils from 10 per cent. to 35 per cent.; of heavy oils from 10 per cent. to 20 per cent.; and of pitch from 30 per cent. to 60 per cent. The wide variations in composition are due to differences in the temperatures at which the carburetting and superheating chambers of the gas-making plant have been worked, and to differences in the ratio of oil used to water gas made and in the nature of the oil used. The light oils are physically, if not chemically, very similar to the light oils of coal tar. The middle oils, however, cannot properly be regarded as creosote oil because they yield only at the most 1 per cent. to 2 per cent. of tar acids. They frequently, also, are almost free from naphthalene, but this depends on the mode in which the carburetted water gas plant has been operated. The heavy oils contain less anthracene than the corresponding oils from coal tar. There is less free carbon in the pitch than in coal tar pitch, the amount seldom exceeding 10 per cent. The oils, particularly the light oils, have a very penetrating and, to most people's senses, very offensive smell, which appears to be communicated to milk and uncooked meat or fish which is exposed to it, so that they become tainted thereby. On this account, carburetted water gas tar is now seldom used in a crude or unmixed state for the treatment of roads; but on those of the smaller gasworks which possess water gas plant the tar produced therein is frequently run into the same storage tanks as coal tar, and the mixture is sold as gas tar.

Blast furnace tar, which is occasionally used for the treat-

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ment of roads, is a local production, being obtained from the blast furnaces which use Scotch splint coal as fuel. Its specific gravity is usually about 1·1. It contains in its crude state from 1 per cent. to 10 per cent. of water, which, however, contains only a small proportion of ammonia as compared with the ammonia in the gas liquor of coal tar. The proportion of light oils is usually lower than in crude coal tar, the proportion of middle oils 20 per cent. to 30 per cent.; that of heavy oils 5 per cent. to 15 per cent.; and of residual pitch 50 per cent. to 70 per cent. The middle oils contain a high proportion of tar acids, viz. about 30 per cent. to 40 per cent. of their volume. They are sold as blast furnace creosote. The middle oils and heavy oils contain very little naphthalene and anthracene, and are more freely fluid than the corresponding oils of coal tar. The pitch contains from 5 per cent. to 20 per cent. of free carbon.

Producer Tar.—Certain types of gas producer using bituminous coal or slack also yield tar which is sometimes offered for use on roads. It varies considerably in character, but generally speaking, producer tars are not very suitable for application to roads, and as their production is at present relatively small and somewhat local it has not been thought necessary to investigate specially their effect on fish life.

6. Nature and Composition of Natural Asphalts, etc.

The natural asphalts and asphaltums vary so greatly in nature and composition that it would be out of the question to refer to them in detail in a paper of this character. Generally speaking, however, the bituminous matter contained in natural asphalt rocks, in liquid asphaltums, and in petroleum oil residuum is free from phenols. Water which has been in intimate contact with certain of these natural materials may become highly tainted so far as taste and smell are concerned, but this tainting is not caused by all such materials, and, as will appear later, when it occurs is not usually highly detrimental to fish life.

7. The Method of Investigation.

The investigations were carried out on water which had been agitated, or otherwise brought in contact in the manner stated, with the particular tar or road-treating material which

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was the subject of study at the time, and on aqueous solutions of determined strength of various components of tar, etc. The amount of certain important impurities in the water which had been agitated with tar, etc., were, where possible, determined. By judicious choice of representative tars and of solutions of particular ingredients of them, it was hoped that light would be thrown on the relative effects of different tars and of their components on fish life in water which had been in contact with, or which contained, them. The preliminary experiments were made with either gudgeon or dace, or both, and when the information thus gained showed that further investigation was desirable, they were extended to other fish. The results with dace and gudgeon will be given in the first instance, and the relative susceptibility of different fish to the toxic action of the more important solutions will be referred to separately. The water or solution used in each case was contained in a glass vessel of 5 or 6 gallons capacity, into which one or more fish were put. The fish were watched, and the time of the first symptoms of their being harmfully affected was noted, as well as the time of death, if death ensued. Individual specimens of the same species were sometimes found to differ considerably one from the other in their resistance to the effects of poison, but the number of experiments made in most cases allowed of conclusions being drawn, which fairly represent the average susceptibility of the species. When fish which ordinarily live in water which is highly aerated were being studied, special means of agitation were adopted to keep the water sufficiently well aerated.

8. The Effect on Fish Life of Different Components of Coal Tar.

It will be most convenient to deal in the first place with the more important components of coal tar and afterwards to refer to water which has been in contact with coal tar itself. For this purpose the components of coal tar which require special consideration are: (i) *the water or gas liquor;* (ii) *the tar oils and their associated bodies;* (iii) *the pitch.*

(i) *The Ammoniacal Liquor and its Ingredients.*—The water or liquor contained in crude coal tar is an aqueous solution of ammonia and a number of compounds of ammonia and of

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phenols and small proportions of the basic bodies contained in coal tar. The free and combined ammonia present in the liquor, which is known as "gas liquor" or "ammoniacal liquor," may be divided into two groups, viz. (*a*) free ammonia and the compounds of ammonia with carbon dioxide and sulphur, and (*b*) the more stable compounds which ammonia forms with several acid radicles. It will be convenient to refer to the ammonia of the first group as "volatile" ammonia, and that of the second group as "fixed" ammonia. The greater proportion of the ammonia in gas liquor is "volatile," but the ratio of "volatile" to "fixed" ammonia varies with the ammoniacal strength of the liquor and the point in the train of condensing and tar and ammonia extracting apparatus on the gasworks at which the liquor (or the tar containing it) has been collected. The mixed liquor from all points, if of about the standard (10-"ounce") strength, contains about five-sixths of its ammonia in the "volatile," and one-sixth in the "fixed" state. The liquor present in tar varies greatly in strength, but is usually considerably lower than 10-"ounce," and in that case more than one-sixth of its ammonia will be in the "fixed" state. It will appear later that the "volatile" ammonia is of much greater moment than the "fixed" in regard to the pollution of fishing-waters, but, as certain of the "fixed" ammonia compounds in gas liquor can be detected with certainty when present in water in extremely small proportion, and as these compounds are unlikely to be derived from any source other than gas liquor, the "fixed" ammonia becomes important as a clue in the detection of pollution of water by gas liquor or crude coal tar.

Gas liquor ordinarily contains about 0·2 per cent. of phenols, the amount increasing to a maximum of nearly 0·4 per cent. in liquor which has been deposited, or otherwise brought into intimate contact, with tar, and decreasing to a trace in liquor from the last washing plant on the gasworks.*

The "volatile" ammonia consists, as already indicated, of free ammonia, ammonium sulphide and ammonium carbonate. The "fixed" ammonia consists chiefly of ammonium sulphocyanide (thiocyanate), ammonium ferrocyanide, ammonium thiosulphate, ammonium chloride, and ammonium sulphate.

* Cf. F. W. Skirrow, "Journal of the Society of Chemical Industry, 1908," p. 58.)

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Table I. shows the effects on fish of solutions of these salts of ammonia of different strengths. The strengths of the solutions are stated in parts by weight of the salt in 1000 parts of water (i.e. in grammes per litre), but in another column the

TABLE I.—EFFECT ON FISH LIFE OF SOLUTIONS OF AMMONIA AND ITS SALTS.

Salt.	Parts of salt per 1000 parts of water.	Equivalent parts of ammonia, free or combined, per 1000 parts of water.	Minutes which elapsed before death.	
			Gudgeon.	Dace.
Ammonia	1·0	1·0	1·5	—
„	0·1	0·1	6	2·5
„	0·02	0·02	130 100 100	100
„	0·0148*	0·0148	60	—
„	0·01	0·01	720	1800
„	0·004	0·004	Unaffected	Unaffected
Ammonium sulphocyanide.	0·1	0·0227	360	Unaffected
„ „ ..	0·01	0·0023	Unaffected	—
Ammonium sulphate ..	1·0	0·257	60	60
„ „ ..	0·1	0·026	Unaffected	Unaffected
Ammonium sulphide ..	1·0	0·5	105	†
„ „ ..	0·1	0·05	Unaffected	Unaffected
Ammonium carbonate ..	1·0	0·354	180	—
Ammonium chloride ..	1·0	0·318	360	—
Ammonium ferrocyanide ..	0·1	0·024	Unaffected	—
Ammonium thiosulphate ..	0·1	0·023	Unaffected	‡
	Vols. of 10 ounce liquor per 1000 vols of water.§			
Gas liquor	1·00	0·0217 (exclusive of fixed ammonia)	105	100
„	0·92	0·0200 „	110	105
„	0·10	0·0022 „	Unaffected	—

* Experiment reported by Dr. Gardiner.

† Tench died in 260 minutes.

‡ Tench unaffected.

§ 10 ounce strength by direct titration, and therefore exclusive of the fixed ammonia present.

calculated proportion of ammonia contained in the salt is also shown. A result reported by Dr. J. E. Gardiner in evidence in a case of alleged poisoning of fish by gas liquor has been interpolated.‖

‖ See the "Journal of Gas Lighting," vol. cxvi. p. 627.

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It will be seen that free or real ammonia is very deadly to fish, and next to it come in order the sulphocyanide, the sulphate, the sulphide, and the carbonate. The sulphocyanide and sulphate are not present in large proportion in gas liquor, the effect of which will, however, vary slightly according to its composition, which depends on the point in the train of condensing and ammonia extracting plant on the gasworks from which it has been obtained. The results for a typical sample of liquor are shown in Table I. and indicate that it is nearly as deadly to fish as is water containing the equivalent amount of ammonia wholly in the free state. But in addition to ammonia and its salts, gas liquor contains, as already stated, a certain amount of phenols, solutions of which, if above a certain strength, are deadly to fish. The precise effect of solutions of phenol of different strength will be dealt with shortly. The presence of phenol in gas liquor may, however, account for it being considerably more deadly to fish than are solutions of carbonate and sulphide of ammonia of the same ammoniacal strength. Other salts of ammonia are only of minor importance, though it should be noted that the sulphate, which is largely used as a fertiliser, is more deadly than most of the other fixed salts of ammonia. This point will be referred to subsequently, when the effect of fertilisers in general is considered.

(ii) *The Tar Oils and their Associated Bodies.*—The tar oils have to be considered from two points of view, viz. as oils which, by forming films or otherwise, may interfere with the proper aeration of water, and as solvents or carriers of other substances which are directly poisonous or harmful to fish. The lighter oily constituents of coal tar, viz. the oils distilling below about 170 deg. C. have generally a lower specific gravity than water and therefore if, in a free state, they enter water-courses, they will spread over the surface and form a film which will cover a very large area of water. It is difficult to judge the precise harmfulness of such a film in preventing the proper aeration of water, but evidently running water in which the surface is continually broken, will be less affected than still water. Even with such water, however, if oil is present in substantial quantity, its effect in soothing troubled waters has to be borne in mind. An attempt to ascertain experimentally if a film of the light oils from coal tar was directly harmful to

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fish was made by pouring one part of crude light oil on to 1000 parts of water, and putting gudgeon in the latter. The gudgeon died in three hours (see Table II.). There is evidence that mineral oils are nearly as good solvents of oxygen as water, so that the aeration of water does not appear to be inhibited by a film of mineral oil. Experiments were made on gudgeon with gasoline and a heavy automobile mineral lubricating oil, applied to water in the same proportion (1 to 1000) and in the same way as the crude light oil. The gudgeon were unaffected by the film either of gasoline or lubricating oil. In regard to the crude light oils of coal tar, however, it may be pointed out that they act as solvents of phenol and other toxic ingredients of tar, and are not simply neutral oils. The film-forming power of coal tar depends chiefly on the proportion of light oils in it, and it appears that the film of crude light tar-oils is rather more deleterious to fish-life than the film of mineral fuel and lubricating oils.

The middle oils of coal tar are heavier than water and will not ordinarily cause an appreciable film on the surface. They contain in solution or admixture, as already stated, more or less naphthalene, which is a solid which is practically insoluble in water. A quantity of clean naphthalene was suspended in a muslin bag in water, and neither gudgeon nor dace in the water were affected by it in the least. The middle oils contain also varying quantities of tar acids, or crude phenols, and also various basic bodies. The middle oils obtained when tar is distilled in a tar distillery are sold either in the crude state for the creosoting or pickling of timber, etc., or the tar acids are extracted from them by washing with caustic alkali, and are worked up into carbolic acid and other phenolic preparations. Caustic alkali completely extracts the phenols, but they are extracted to a certain small extent by water, in which they are slightly soluble at ordinary temperatures. A certain proportion of phenols may thus be extracted from the crude middle oils of coal tar by agitating water with them. The effect on fish of water which has been in contact with the middle oils of coal tar depends mainly on the amount of tar acids in the oil, but since the oil itself is not appreciably soluble in the water unless specially emulsified (as in commercial "soluble creosote") the effect is largely influenced by the extent to which the tar acids are extracted by the water on mere contact or agitation with the oil.

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The heavy oils of coal tar do not contain phenols or other bodies which are known to have any directly poisonous action, or which are appreciably soluble in water.

The effects on gudgeon of water which has been mixed as far as possible with various tar oils in the proportions stated are shown in Table II.

Experiments were also made with various pure substances which are contained in, or may be extracted from, the tar oils. The most important of these is phenol (carbolic acid). Pure phenol was dissolved in water in known proportions and the effects of the solution on fish observed. The results are included in Table II. Similar experiments were made with Calvert's "No. 5 Carbolic Acid," which consists chiefly of cresols (the next higher members to phenol of the phenol series), and with certain basic bodies derived from coal tar, viz. aniline, toluidine and pyridine. The results of these experiments are also shown in Table II.

TABLE II.—EFFECT ON FISH LIFE OF COAL TAR OILS AND THEIR CHIEF ASSOCIATED BODIES.

Substance.	Parts of substance per 1000 parts of water.	Minutes which elapsed before death.	
		Gudgeon.	Dace.
Phenol	0·210	45	35
„	0·100	60	60
„	0·0125	†	†
„	0·010	Unaffected	—
No. 5 carbolic acid	0·219*	70	70
„ „	0·010*	2160	—
Soluble creosote, 2 per cent. tar acids	0·100	90	—
Creosote oil, 14 per cent. tar acids ..	0·250	180	—
„ 2 per cent. „ ..	1·000	240	—
Crude light oil	1·000	180	—
Crude heavy oil	1·000	240	—
Aniline	1·000	40	—
„	0·100	180	480
Toluidine (ortho-)	0·100	180	—
Pyridine	0·100	Unaffected	Unaffected
Naphthalene	>1·000	Unaffected	Unaffected

* Parts of tar acids, reckoned as phenol, determined by bromine.

† Dace much affected, and gudgeon slightly affected in 6 hours, when they were returned to fresh water and both recovered.

The import of the results given in Table II. and their bearing on the question of the effects on fish life of washings from

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tarred road surfaces, will be discussed in connexion with the results obtained with water which has been in contact with tar.

(iii) *The Pitch.*—Coal tar pitch consists of substances which are relatively inert, and hence it is not surprising that it was found that water in which small lumps of pitch were suspended in a muslin bag proved to have no effect on gudgeon and dace.

9. The Effect on Fish Life of Water which has been in Contact with Coal Tar.

A number of experiments were made in order to obtain direct evidence of the effects on fish life of water which has been in contact with coal tar. The experiments may be conveniently arranged in four series as follows: (1) Tar and water in definite proportions were agitated very vigorously for fifteen minutes at a known temperature, and fish were kept in the extract thus obtained and the effects observed; (2) Tar was placed in the bottom of a vessel, a false perforated bottom was put over it, the vessel was filled with water, and fish were put in the water and the effects observed; (3) The whole inside surface of the vessel was painted with tar, which was allowed a certain time to set, and the vessel was then filled with water, in which fish were put and the effects observed; (4) A large tray was painted with tar, which was then sanded; a spray of water was allowed to fall on the tarred and sanded tray in imitation of rainfall; the washings were collected and their effect on fish observed. Approximate determinations of the strength of the extracts and washings in phenolic constituents were made for purposes of control by means of bromine water.

The majority of the experiments were made on four samples of coal tar, each chosen as typical of a different grade. The composition and general characteristics of these samples of tar are shown in Table III., in which are included the similar particulars in regard to the sample of "freed" carburetted water gas tar, and the sample of blast furnace tar, on which experiments, referred to later, were made.

In the first series of experiments a number of trials were made of agitating tar with different proportions of water at different temperatures. It was found that the phenolic strength

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of the extract depended on several factors, of which the most influential were the viscosity of the tar at the temperature of agitation, the proportion of tar acids in the tar, and the vigour with which the tar and water were agitated. The effect of temperature seemed to depend mainly on the consequent alteration in the viscosity of the tar. Within a fairly wide range the phenolic strength was not very greatly affected by the proportion of water to tar, and the extracts of which the effects are reported below were mostly obtained by agitating 1 part of tar with 200 parts of water. A number of experiments were made, however, on extracts obtained by agitating 1 part of tar with 20 parts of water, and on these extracts diluted by addition of water. Tar which had been extracted by agitation with one lot of water, on agitation with a fresh supply of water yielded to the second extract an appreciably lower amount of phenolic constituents than to the first. The effects on gudgeon and dace of extracts of tar prepared by vigorous agitation of water and tar in the proportions and at the temperatures stated, are shown in Table IV.

TABLE IV.—EFFECT ON GUDGEON AND DACE OF AQUEOUS EXTRACTS OF COAL TAR, OBTAINED BY VIGOROUS AGITATION FOR FIFTEEN MINUTES.

Tar used (see Table III.).	Vols. of water agitated with one vol. of tar.	Temp. of water during extraction. Fahr.	Phenolic bodies reckoned as phenols in the extract. Grammes per litre.	Minutes which elapsed before death.	
				Gudgeon.	Dace.
A (crude light) ..	200	70	about 0·14	15	14
B (crude heavy) ..	200	70	„ 0·06	80	40
C ("freed" light) ..	200	70	„ 0·21	30	20
C „ „ ..	200	70	„ 0·17	30	36
C „ „ ..	200, diluted to 400	70	„ 0·09	120	31
C „ „ ..	20 „ 200	70	„ 0·02	720	360
C „ „ ..	20 „ 200	46	„ 0·01	1140	360
D ("freed" heavy)	200	70	—	135	45

There are a number of small discrepancies in the Table, which may be readily accounted for by uncontrollable differences in the vigour and temperature of agitation, and the variations in the power of resistance of different specimens of the same species of fish. The outstanding feature of the results is, however, that the extracts of crude tars are more deadly to fish than extracts of "freed" tars of corresponding phenolic strength.

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TABLE III.—PARTICULARS OF TARS USED.

Distinctive letter. / Description of tar.	A. Crude coal tar (light).	B. Crude coal tar (heavy).	C. "Freed" coal tar (medium light).	D. "Freed" coal tar (medium heavy).	E. "Freed" carburetted water-gas tar.	F. Scotch blast furnace tar.
Specific gravity at 15·5 deg. C. (60 deg. Fahr.)	1·160	1·274	1·185	1·208	1·085	1·155
Water; per cent. by weight	5·5	6·2	0·1	0·1	0·3	1·9
Ammonia; grains per gallon of tar	72·0	58·0	Nil	Nil	Nil	1·6
Light oils, distilling below 170 deg. C.*	3·0	2·0	0·6	0·2	1·7	0·5
Middle oils, distilling between 170–270 deg. C.* (per cent. by weight of the dehydrated tar)	22·0	9·0	23·4	16·1	31·4	23·5
Heavy oils, distilling between 270–300 deg. C.* (per cent. by weight of the dehydrated tar)	5·2	1·7	8·8	6·8	13·3	7·7
Pitch .. .. (per cent. by weight of the dehydrated tar)	68·6	85·3	66·8	76·8	53·1	67·8
Crude tar acids; per cent. by volume of the middle oils	14·0	<1·0	10·0	5·0	<1·0	35·0
Crude tar acids; per cent. by volume of the tar	3·2	—	2·5	0·9	—	8·6
Free carbon, per cent. by weight of the dehydrated tar	8·5	27·7	15·6	15·8	trace	7·0
Viscosity at 76 deg. Fahr. Time required to flow through an orifice through which refined rape oil in the same conditions flowed in two minutes: Minutes	2¾	660	10	60	⅓	43½

* The temperatures during distillation were observed on a thermometer, the bulb of which was opposite the side tube of the fractionating flask.

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There is a general agreement in the results with extracts of "freed" tars and solutions of phenol (see Table II.) of the same strength, though the extracts of tar seem slightly more deadly than would be expected from their phenolic strength alone. There is probably some other constituent of the tar extracts which is distinctly harmful to fish life, but until further investigations of the composition of the tar extracts have been made conjectures as to the nature of this constituent are of little value.

In the second series of experiments, 1 volume of tar was put in the bottom of a vessel and 20 volumes of water added. Fish were put in the water at once, being protected from contact with the tar by a perforated screen placed above it. Two tars, viz. C and D, were tried in this manner with dace and gudgeon. With C the fish died in less than 18 hours, but with D they lived for 24 hours, when they were removed from the water. Carp remained alive in the water in contact with tar C, and though much affected towards the end of the 18 hours, recovered when put in fresh water.

In the third series the first experiment was made with tar C, which was painted on the whole of the inside of the vessel and allowed ten days to harden. Water was then poured into the vessel and gudgeon and dace placed in it. The gudgeon died in 17 hours, the dace in 30 hours. In the second experiment the inside of the vessel was painted with tar D, which was allowed five days to harden. The vessel was then filled with water. A perforated sheet was placed over the bottom, and trout, grayling, gudgeon and dace were placed in. The grayling was affected in less than 1 hour, and the gudgeon appeared to be slightly affected in less than 2 hours. The trout and dace were not affected in 2½ hours. Water was then allowed to play into the vessel in a jet at the rate of about one litre in 2½ minutes (= about 5 gallons an hour)—the surplus being removed by a constant level overflow—and all the fish then remained alive for 48 hours (when they were removed); the trout and dace not having shown any signs of being affected throughout the experiment. The rate of flow of the water was such relatively to the water content of the vessel at the level to which it was filled that the water would be wholly renewed in 35 minutes. Subsequently two carp, a perch, two roach, two trout and a number of gudgeon were kept for six days in the

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same tarred vessel in the same conditions, and remained unaffected throughout.

In the fourth series of experiments a tray was painted with tar, and sand sprinkled on the tarred surface. After a lapse of 18 hours water was sprayed on the tar in imitation of rainfall, and the washings were collected. The rate of sprinkling was equivalent to a rainfall of one inch in 2 hours 8 minutes. One experiment was made with tar C, and trout, perch, gudgeon, roach and minnow were placed in the water. The perch died in 180 minutes, the minnow in about 240 minutes, while the trout, gudgeon and roach, though affected, remained alive for 5 hours, but all died in less than 17 hours. The same tarred surface was sprayed a second time, and gudgeon placed in the washings remained alive for over 7 hours. A similar experiment was made with tar D, and trout, grayling, pike, perch, dace, gudgeon and tench were put in the washings. The trout died in 130 minutes, the perch in 275 minutes, the pike in 345 minutes, the grayling in 495 minutes, the dace in about 720 minutes, while the tench remained alive for over 24 hours, and the gudgeon for over 48 hours, when it was restored to fresh water and recovered. A portion of these washings was diluted with twenty times its volume of clean water, and trout, roach and gudgeon were put in the diluted washings. They remained unaffected for 6 hours, when they were removed.

10. The Effect on Fish Life of Water which has been in Contact with Carburetted Water Gas Tar and Blast Furnace Tar.

Experiments were made on a "freed" or "dehydrated" carburetted water gas tar, and a Scotch blast furnace tar, of which particulars are given in columns E and F of Table III.

The carburetted water gas tar, when mixed with water in the proportion of 0·1 part of tar to 1000 parts of water gave a film on the surface of the water, but did not affect gudgeon. The tar, when agitated vigorously for 15 minutes with water in the proportions and at the temperatures stated, gave the results shown in Table V.

The bromine method for the estimation of phenol when applied to extracts of water gas tar proved quite unreliable, doubtless owing to the presence of unsaturated hydrocarbons

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TABLE V.—EFFECTS ON FISH LIFE OF AQUEOUS EXTRACTS OF CARBURETTED WATER GAS TAR AND BLAST FURNACE TAR.

Tar used (see Table III.).	Vols. of water agitated with one vol. of tar.	Temp. of water during extraction. Degrees Fahr.	Minutes which elapsed before death.	
			Gudgeon.	Dace.
Carburetted water gas tar (E) ..	20	—	120	—
„ „ ..	200	70	280	105
Blast furnace tar (F)	20	—	20	—
„ „ ..	20, diluted to 100	—	240	—
„ „ ..	200	70	25	15

in the tar. Qualitative tests did not show the presence of phenols in the extract. The tar, however, being practically free from tar acids, would clearly yield very little, if any, phenol to a water extract, and the toxic ingredient in the extract is evidently not phenol. The extract retained a strong smell and taste of the tar.

Experiments were made with the blast furnace tar, F, by agitating it vigorously with water for 15 minutes in the proportions and at the temperatures shown in Table V. The extracts were all coloured deep red, and smelled and tasted of the tar. An estimation by means of bromine of the phenolic bodies in the extract made with 200 volumes of water to 1 of tar showed a strength of 0·16 part of phenoloid bodies reckoned as phenol per 1000 parts of extract. This is a lower phenolic strength of the extract than might have been expected from the large proportion of tar acids in the tar, but the latter is highly viscous, and does not therefore readily commingle with the water during agitation.

The middle or creosote oils from blast furnace tar are known commercially as "blast furnace creosote," and this oil has been used in the preparation of certain compositions sold as dust-abaters. An experiment was made on a mixture of 0·1 part of blast furnace creosote with 1000 parts of water. Gudgeon put in this water died in 210 minutes.

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11. The Effect on Fish Life of Water which has been in Contact with Asphalts, etc.

The results of experiments made with three well-known types of bituminous materials, two of natural origin, and one prepared from petroleum residues, may be briefly mentioned.

A sample of the Neuchatel natural rock asphalt containing 7·2 per cent. of bituminous matter was broken to lumps about the size of a pea and suspended in a muslin bag in water. Gudgeon placed in this water were unaffected.

A liquid asphaltum from Trinidad containing over 99 per cent. of extractable bituminous matter was agitated vigorously with twenty times its volume of water, and gudgeon placed in the aqueous extract were unaffected. This extract smelled very strongly of the asphaltum.

"Roadoleum A", which is prepared from American petroleum, was put in a vessel which was filled with water. Gudgeon remained unaffected in the water.

12. The Effect on Fish Life of Water which has been in Contact with Agricultural Fertilisers: *Nitrate of Soda, Sulphate of Ammonia, Lime, Stable Manure, etc.* [*Weed Killer*].

Experiments were made on the effect on fish life of solutions of two of the best known artificial fertilisers, viz.: sodium nitrate and ammonium sulphate; as well as of solution of lime ("lime water"), the natural drainage from heaps of stable manure, and extracts prepared by agitating water with fresh and old stable manure. The results are shown in Table VI.

The preparations of stable manure were all deep brown and opaque. Probably the greater part of the ammonia estimated on distillation of them was formed from other nitrogenous bodies during distillation, and no easy method of determining the ammonia present as such in the extracts suggested itself.

The investigation of these materials was undertaken because it appeared possible that the surface drainage from agricultural land which had been recently treated with the fertilisers named might affect fish life in streams into which it passed, and that injury to fish life really due to fertilisers might be attributed to tarred roads in the vicinity. The effects of the extracts of

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stable manures were specially studied because the waterproofing of the road surface by means of tar and similar materials seemed likely to cause more concentrated extracts of horse droppings than formerly to be washed from the road surface into streams.

TABLE VI.—EFFECT ON FISH LIFE OF SOLUTIONS OR EXTRACTS OF FERTILISERS.

Substance.	Strength; parts per 1000 parts of water.	Minutes which elapsed before death.		
		Gudgeon.	Dace.	Minnow.
Sodium nitrate ..	1	Unaffected	Unaffected	—
Ammonium sulphate	1	60	60	—
" "	0·1	Unaffected	Unaffected	—
Lime	1	20	45	—
"	0·1	Unaffected	Unaffected	—
Stable manure, natural drainage from	Diluted till the yield of ammonia on distillation was equal to 0·2 part	1440	210	135
Stable manure, fresh; artificial extract ..	0·2 part	—	—	150
Stable manure, old; artificial extract ..	0·2 part	—	—	about 150

It appears from the results that there is somewhat greater risk of injury to fish life from the use of sulphate of ammonia than from the use of nitrate of soda, though the fact that the former fertiliser has been applied in enormous quantities for years past without definite cases of injury to fish having arisen, indicates that the solution extracted from the treated soil is naturally diluted to an extent which brings its strength below that which has been found by these experiments to be harmful. The same remark applies to the effect of extracts of stable manure. The dilution which naturally occurs before the extracts pass into fishing waters is so great that no injury to fish arises from them. The fact, however, that both artificial and natural manures may, in solutions or extracts of strength comparable with the strength of solutions or extracts of tar and tar products prepared in a similar manner, as described earlier in this paper, cause injury to fish, has an important bearing on the results which may be anticipated from tarred surfaces, etc., when exposed in natural conditions. It is clear that the concentration obtained artificially is in all cases much greater than

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would ever occur naturally, and consequently the results with the artificial preparations greatly exaggerate those which can ensue in natural conditions.

Cases of poisoning might arise from the use of arsenical weed-killers in the vicinity of fishing streams, and it therefore seemed desirable to observe the effect on fish of a dilute solution of arsenic trioxide (white arsenic). A solution of 0·1 part of arsenic trioxide in 1000 parts of water had no effect on gudgeon for several hours, but later the fish were affected and died in 48 hours.

13. Relative Susceptibility of Different Species of Fish to Ammonia and Tar Poisoning.

It is difficult to determine exactly the relative susceptibility of different species of fish to poisoning owing to differences in the powers of resistance of individual specimens, and to the different natural conditions in which different species of fish thrive best. With trout and other fish which prefer fast running streams, thorough aeration of the water is essential, and it has proved somewhat difficult to imitate natural aeration with the limited quantities of water or solutions on which the experiments have been made. But making allowance for the cases of experiments in which the aeration is known to have been somewhat imperfect, and taking the results of a fairly large number of experiments on the fish named, it may be predicted that in cases of ammonia poisoning or of poisoning by extracts of freed coal tar or solutions of phenol, the fish would be affected and would die in the order indicated in Table VII.

Table VII.—Relative Susceptibility of Fish to Ammonia and Tar or Phenol Poisoning.

Order.	Ammonia poisoning.		Phenol or coal tar extract poisoning.	
	Affected.	Died.	Affected.	Died.
1	Perch	Perch	Grayling	Perch
2	Pike	Trout	Perch	Trout
3	Pope	Pike	Trout	Minnow
4	Trout	Dace	Pike	Pike
5	Dace	Pope	Pope	Grayling
6	Gudgeon	Tench	Minnow	Pope
7	Tench	Gudgeon	Roach	Roach
8	Carp	Carp	Gudgeon	Dace
9	—	—	Dace	Gudgeon
10	—	—	Tench	Tench
11	—	—	Carp	Carp

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The conclusions in regard to ammonia are based on fewer experiments than those in regard to tar or phenol, and consequently the order in which the species are ranged is less well established in the case of ammonia. "Affected" is used to indicate that the fish has begun to behave in an abnormal manner—in the case of ammonia poisoning, the first untoward symptoms are commonly sudden convulsive movements with violent dashing through the water, and in the case of phenol poisoning the fish gradually turns on its back without paroxysms. Death frequently occurs quite suddenly from ammonia poisoning, but generally slowly from phenol poisoning.

14. The Practical Bearing of the Experimental Results.

The results of the more important experiments have now been recorded, with as much detail as has seemed necessary to provide the data on which trustworthy conclusions may be based.

The Author will briefly indicate some of the conclusions which he draws from the results of the investigation:—

(1) That ammonia and many of its salts are very highly toxic to fish, and gas liquor is nearly as toxic as clean water containing the same proportion of free ammonia;

(2) That it follows that the use on roads of coal tar containing gas liquor (*i.e.* crude tar) is attended by appreciably greater risk of injury to fish life than is the use of coal tar which has been "freed" from gas liquor;

(3) That of the oils contained in coal tar, the "light oils" are the most harmful to fish life, and since the light oils are to a large extent removed from coal tar by the procedure which is followed for the removal of gas liquor, an additional reason is afforded for preferring "freed" to crude coal tar;

(4) That the phenols are highly toxic to fish, though less so than ammonia;

(5) That tars in which phenols and allied bodies ("tar acids") are present in high proportion may render water which has been in intimate contact with the tar toxic to fish in degree approximately corresponding with the amount of phenoloid bodies acquired by the water from the tar;

(6) That, other things being equal, water acquires a smaller

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proportion of phenoloid bodies from a thick highly viscous tar than from a thin, freely fluid tar;

(7) That, taking into consideration (5) and (6) and the fact that light thin coal tars generally contain a larger proportion of tar acids than heavy thick coal tars, the use on roads of light thin coal tars is attended by appreciably greater risk of injury to fish life than the use of heavy thick coal tars;

(8) That the risk of injury to fish life from the use of "freed" coal tar on roads is negligible provided the tar contains less than 3 per cent. by volume of crude tar acids, and the area of the tarred surface is not greater than one-twentieth of the total area of ground draining into a water-course;

(9) That naphthalene and coal tar pitch are not distinctly harmful to fish life;

(10) That the use on roads of a "freed" carburetted water gas tar is attended by less risk of injury to fish life than the use of a "freed" coal tar. (The use of "crude" carburetted water gas tar is, however, inadmissible owing to the large proportion of light oil in it);

(11) That the use on roads of blast furnace tar, or of preparations containing much blast furnace creosote, is attended by considerably greater risk of injury to fish life than the use of a "freed" coal tar;

(12) That some important natural asphalts and asphaltums and petroleum preparations are not distinctly harmful to fish life;

(13) That the use of salt water, or of calcium chloride for dust abating is not attended with risk of injury to fish life;

(14) That there is a remote risk of injury to fish life from washings from accumulations of horse-droppings or stable manure, and that the use of sulphate of ammonia as a fertiliser is attended by appreciably greater risk of injury to fish life than the use of nitrate of soda. All the risks referred to in this paragraph are, however, in all ordinary circumstances so remote that they are negligible.

15. Suggested Provisions for Safeguarding the Surveyor in the Use of Tar.

The conclusions set out above disregard all considerations other than the effect of the materials, etc., on fish life. It is

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not the purpose of this paper to deal with the other considerations which enter into the choice of road-surfacing materials by the surveyor. But bearing in mind this limitation, the surveyor may, in the Author's opinion, safeguard himself in the use of tar on roads in all ordinary cases, if he uses only coal tar or a mixture of coal tar and carburetted water gas tar, which in either case: (1) is of not lower specific gravity at 15 deg. C. than 1·18; (2) contains not more than 1 per cent. of water or gas liquor, the ammonia in which is equal to not more than 5 grains per gallon of tar; (3) contains not more than 1 per cent. of light oils; and (4) contains not more than 3 per cent. by volume of crude tar acids.

If cases occur where the washings from tarred roads will not be diluted to at least twenty times their volume before, or immediately on, entry to fishing waters, the maximum limit of water or liquor in the tar should be reduced to 0·2 per cent.; of ammonia to 1 grain per gallon of tar; and of light oils to 0·8 per cent. (or 1 per cent. of distillate below 170 deg. C. inclusive of water). As an extreme precaution in certain cases, a tar prepared from pitch and "dead" tar oils (*i.e.* middle and heavy tar oils from which the phenols have been extracted) might be used, and when the market value of carbolic acid, etc. is high, the cost of such a prepared tar should not be very much greater than that of an ordinary good "freed" coal tar.

It has not appeared to the Author desirable to include in this paper analytical details. He hopes to find shortly a fitting opportunity to present a paper on the detection and estimation of small quantities of phenols in water.

The Author desires to record his thanks to Mr. F. L. Bassett, B.Sc., A.I.C., for help and valuable suggestions in connection with the investigations.

DISCUSSION.

MR. R. J. THOMAS: I have the pleasure of proposing a very hearty vote of thanks to Mr. Butterfield for a most excellent paper, which must be of infinite assistance to every road surveyor who is compelled by modern traffic requirements to use something besides water in binding his roads. The experiments detailed in the paper are most interesting, but I do not know

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that Mr. Butterfield will say they are entirely conclusive. I presume they are more in a general form than in absolute proportion, because from the little I have had to do with fish, I think you will find very few alike either in strength, temperament, or even the way in which they will take the hook. I think the whole point lies in the question of cost to the road authorities—I refer to the purchase of distilled tar. That is what it means. Unfortunately, in my county we have not been able to afford to purchase anything but crude tar. We have used it for eight years, doing upwards of 100 miles annually, and so far we have paid no claim at all. I think I might attribute that to two reasons, the first being that we take very great care to screen our tar, and to well boil it; and the second, that in applying it to the road our object is not to leave a film or a skin on the road, but to drive the hot tar as deep as we can into the interstices of the road. By doing this I have not found any great risk of the escape of any quantity of tar into the road gutters. The only occasion on which there is a danger—and it appears to me a great danger—of pollution is when you are busy with five or six machines in different parts of the county, and you get a heavy thunderstorm before the tar has had time to penetrate into the road. Then I admit there would be great danger of pollution. I find that by concentrating the outlets on the roadside, and having at each of those outlets a filter formed of three grades of gravel reduced to fine sharp sand, we get, apparently, an effluent which does no harm at all. We have two or three celebrated fisheries in our county,—quite apart from the River Thames, the conservators of which are very keen,—and one owner suggested to us some time ago, not that he had any complaint to make, but as complaints had been made in other places, that we should do what we could to minimise the possibility of any such pollution. We have readily fallen in with this, and by putting in these small filter beds of 6 feet by 5 feet by 3 feet 6 inches deep, the owner of these fisheries has been satisfied. The whole question with us is a question of tar. I buy my tar throughout the county from many local gasworks, and none of those companies are in a position to lay down plant to purify their tar. Unless we bought from them it would mean paying three times as much for distilled tar imported from the large Midland towns, or else reducing the area of tarred roadway by two-thirds. This we certainly do not intend doing. I would very much like Mr.

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Butterfield to express an opinion as to minimising the danger by making the tarring men understand that the tar has to be driven into the heart of the road, and not left upon it in the form of a film ⅛ to ¼-inch thick. Waterproofing has to be effected down below and this not only gives a more substantial waterproofing, but keeps together the granite, so that it is far more capable of doing its work and is more satisfactory all round. We have roads with a penetration of 2½ to 3 inches. It is all done by hand, from portable boilers, but the tar is brushed in by three pairs of men. The first two have medium bass brooms; the second pair heavier bass brooms, and the third pair very strong brushes, worked very hard over the cooling tar.

MR. W. HARPUR: I have very much pleasure in seconding the vote of thanks. At Cardiff I use nothing but distilled tar, and the washings all find their way into the sewers, and thence into the Bristol Channel, where the volume of sewage is absolutely infinitesimal in the volume of water into which it flows, and so there is no risk to fish life. Mr. Butterfield's paper applies almost exclusively to the use of tar upon country roads where the water from the road surfaces gets directly into adjacent streams, and is not previously treated in any way on any sewage purification works. For that reason I think the gentlemen who have the control of country roads will be best able to deal with this question, as it concerns them entirely, and not the towns where there are sewage purification works where any washings from the roads are treated, or where they are turned into the sea, as in my case.

COLONEL CROMPTON: I am in the position of suffering from this fish scare almost more than any man in the country. I have to keep an extra man in my office to deal with questions, not only from the Roads Board, but from various local authorities, automobile clubs, and others, and from France and Germany, asking me to say something authoritative in reference to the scare which the fishermen have got as to the destroying of fish by the use of tar compounds on the roads. The number of fish killed has been so exceedingly small that I doubt whether they have been killed by tar at all. We find dead fish everywhere; but the evidence of dead fish traced to the tarring of the roads is so slight that it is very uncertain whether fish have ever been so killed. Of course, our keen fishermen think otherwise. I agree with every word Mr. Thomas has said. There should not be

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any possibility of any quantity of tar water or ammoniacal liquor being washed off the roads into the streams, and gentlemen of Mr. Thomas's experience have adopted all manner of devices to prevent ammoniacal liquor finding its way to the watercourses. Mr. Thomas has pointed out that he has had no complaints, although he has had skilled experts watching him, and taking every precaution to protect their fish. I do not say for a moment that we should relax any precaution. Turning to Mr. Butterfield's paper you will find that the water used in the experiments had different results on the fish. I would suggest to Mr. Butterfield that you cannot handle fish without making them a little sick, and that these fish all had the influenza before they were subjected to the experiments, particularly gudgeon and dace. If Mr. Butterfield had used eels for the experiment I do not think they would have suffered at all. I believe, if you look at the main cause, the fish were sick before they were put in, and the second cause was want of aeration.

Mr. A. Gladwell: I have noticed Mr. Thomas's system of working on tarred surfaces; and I have also observed with some surprise the results he obtains from the system which he has described of well brushing the tar into the road structure, and allowing it to soak in, instead of putting on other surfacing in the way of chippings or otherwise. I may say that with the exceptions of extreme variations of weather, to which we are subjected, the work certainly does stand very well indeed—very much better than I anticipated it would do, and I hope he will forgive me saying so. As far as I am myself concerned, I lean to the theory and practice of the incorporation of the tar in the structure of the road when reconstructing it. I believe there is a good deal of tar used on the surface of the roads which would be very much better used if incorporated in the structure of the road, because, after all is said and done, I believe the penetration of the tar is not so great as is sometimes imagined. I do not see how it can be, because it is a question more or less of capillary attraction. If you can incorporate the tar into the road by mixing it with your granite, or other methods which some people use, I think you get a better result from the same volume of tar. The intention of the paper is rather to reassure those people who are nervous as to the inimical results which accrue to fish from the use of tar on roads. I think, so far as I am concerned as a road surveyor, if the fish do not like the tar

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they must do the other thing, because the tar has got to be put on the roads. The only thing we can do is to eliminate as far as possible the liability of pollution from tarred water getting into the streams. On the other hand, as tarring goes on, probably the fish will get accustomed to it.

MR. W. V. ANDERSON: I only wish I were as happy about using tar, either crude or distilled, on roads, as Colonel Crompton. Under the circumstances I shall say nothing more on that subject to-night. I should like to ask Mr. Thomas whether any of the small filters of which he spoke were in towns or only on the roadsides of country areas. In my town we have a system with 18-inch pipes, and at times of flood these are running at full bore. Nothing but very large filters would be of any use under these circumstances.

MR. H. PERCY BOULNOIS: The experiments set forth by Mr. Butterfield are within the range of practical politics. Almost any surveyor can carry out these experiments for himself, because they do not require the beautiful analytical paraphernalia which Professor Butterfield has the happiness to possess. The results are given of those experiments, which are fairly simple, in the table, the headings of which show the volumes of water agitated with one volume of tar, and the temperature of the water during extraction (which is practically all through nearly alike, except one, which is 70°); then there are the minutes that elapsed before the fish died. Now what strikes me about this table is that it takes one volume of crude light tar to 200 volumes of water to kill fish in fifteen minutes, while it takes with one volume of crude heavy tar mixed with 200 volumes of water 80 minutes to kill fish. Now the chances of life of fish that have been taken out of their native element, and put in a tank, are much diminished. It is not a healthy, vigorous fish, and all this might be discounted if we applied to an insurance office as to the chance of life of fish which have been taken out of a stream and put into a tank. But apart from this, and admitting that one volume of tar with 200 volumes of water does kill fish, it would be very gross carelessness on the part of any surveyor to allow such a vast volume of tarry water to enter a stream. He must either leave his gulleys unprotected or there must be some other means by which tar gets into the stream in such volume. Fish, I believe, go in shoals; they frequent certain parts of rivers and streams,

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they do not go aimlessly about, and so the tar must reach that part of the stream, and probably even then the tar would be very much diluted. One question I should like to ask Mr. Butterfield is whether a tar which complies with the specification of the Road Board would be inimical or dangerous to fish life; and if so to what extent. It may be that engineers rush in where chemists fear to tread, and it is well that we are brought up occasionally by papers of this kind to know where we stand.

MR. T. MILNE: I must confess I am here as one interested in tar and ammonia, and when I looked through this paper first of all I was a good deal discouraged. But I see it is stated that the conditions under which these experiments were carried out were more or less unnatural or artificial, because we can hardly imagine a fish in its native element, finding itself to be in uncomfortable surroundings, would not get into others less uncomfortable, whereas under Mr. Butterfield's experiment it could not remove itself if it wished to do so. I would like to remark that if surveyors would use water-freed tar, and of a gravity of not less than 1·2, they would have no trouble at all. I think Mr. Butterfield shows where the trouble arises; it comes from the ammoniacal liquor in crude tar. If you free the tar from water you take out the ammoniacal liquor; and at the same time you remove the light oil, which causes the film of which Mr. Butterfield speaks with considerable severity. He says that the film is even worse than ammonia. With water-freed tar you get no film. There is one other point of which Mr. Butterfield speaks, and that has connection with sulphate of ammonia, which is one of the most efficient of fertilisers. If you get it into water there is no doubt it will injure fish. But if you put it into the land it becomes fixed, so that you cannot get it into the water. Owing to certain chemical reactions which immediately begin to take place in the soil, sulphate of ammonia cannot be washed out in the same way as nitrate of soda and other forms of nitrates.

MR. A. DRYLAND: I, like my friend Mr. Boulnois, am not a chemist, and can only speak of what I know—the practical use of tar on roads. I have had considerable experience, and agree with Colonel Crompton that the fears expressed with regard to fish life are fears for which there is very little justification, provided reasonable precautions are taken; more particularly do I think precautions are needed in towns and places

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where there is a surface-water drainage system going direct into streams. On many of our country roads in summer time the water never reaches the streams at all. On the chalk hills, for instance, it is absorbed in the soil; and in those cases there need be no fear of fish life, whether crude or freed tar is used. Personally I know tar will kill fish; I have known instances where it has done so, but they have been exceptional cases, and ought never to have occurred. In my own experience with tar surfacing, which extends over five or six years, over very large areas, I have never had instances of fish being killed, except in two cases under extraordinary circumstances. One was a case where crude tar was used in enormous quantities, so much so that it ran down the channels; and a heavy thunderstorm came on and washed the tar straight into a stream, and it killed the fish. Another case was where some tar-macadam was laid in winter time. It was spread on the road and left unrolled for some days in very wet weather in close proximity to a fishpond. The washings from this tar-macadam were carried direct into the pond. That also killed the fish. But in the general sense of the washings from tarred roads going into streams, I have never had complaints, nor have I any information of fish being phenolically killed or injured. There is very little crude tar used now on roads; we all try to use freed tar. At the same time, there are cases where there is no danger to fish life where crude tar could be used. I agree that these experiments of Mr. Butterfield, though extremely interesting, do not reproduce quite the same conditions as occur in streams. I think it is quite understandable that fish in a vessel in which these dangerous products have been mixed in a certain quantity of water would suffer, and that those fish would die; but I do not think those conditions would obtain in a running stream, where the fish, if they do not like their surroundings, can get away. I do not know that there is anything else I need say, except that Mr. Butterfield's paper shows us we need to use care where there is any danger of tar getting into the streams. It is a thing which all who use tar have in their minds—that precautions must be taken that no evil effects occur. There is not the slightest need for it, and I think there is not the least danger, speaking generally, to the fish life of the country.

Mr. W. Harpur: I have entered very keenly into the discussion which has taken place, and I want to make a suggestion

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before the meeting closes; that is that we make a special appeal to Mr. Maybury to give us a short paper at our Annual Meeting next year giving the results of the experiments he is making, and that he will repeat it the following year. If a visit could also be arranged to the scene of the experimental tests it would also be very interesting.

MR. F. J. WOOD: I had no intention of taking part in the discussion, because the paper is what might be termed academical, and therefore somewhat out of one's sphere. The subject affects me very little, inasmuch as I have made a practice of using only the heavy distilled tar for tarring the surfaces of my roads. I may say that the freed tar mentioned in Table 3D practically complies with my specification. I have not used a tar of less specific gravity than 42° Twaddel, and in no case has it contained water, gas liquor, or ammoniacal compounds. As regards fish, I am sorry to say we have very few rivers in my part of the country, and, so far as fish life is concerned, are not very much troubled with any poisonous matters that may remain in the tar; all the same, it is most important in those counties where there are rivers and fisheries existing that the material used in the treatment of the surfaces of the roads should be free from constituents which may be harmful to fish life. I should like to ask Mr. Butterfield one question. In Table 4 I see that he used D freed heavy tar in the proportion of 1 volume to 200 volumes of water. Did this tar contain any phenolic bodies? as it is shown that gudgeon died in 135 minutes. When the Author used pure phenols diluted in the proportion of 0·1 part in 1000 part of water, as shown in Table 2, the gudgeon died in 60 minutes.

MR. R. J. THOMAS: In answer to the question by Mr. Anderson, I may say the filters referred to are only small filters on small drains on country roads. If Mr. Anderson has an 18-inch stormwater drain running full, and there is strong enough tar in such a volume of water to kill fish, then something ought to be done to stop it. I was discussing surface tarring, not the laying down of tarred macadam, which is an entirely different matter to the paper. Fishermen would acknowledge that at the present time there is an extraordinary disease among fish indicated by a kind of fungus upon them; but this was in existence long before the surfaces of roads were tarred.

THE PRESIDENT: I have the pleasure of conveying to you

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the thanks of the Institution for the interesting and valuable paper you have given us to-night. It will, I am sure, form a most valuable addition to the papers we print in our volume of Proceedings.

MR. W. J. A. BUTTERFIELD in reply said: I thank you extremely for your very kind remarks and for the appreciative way in which you have received this paper. I fully admit that parts of it are, as one speaker put it, academic; but I think from time to time cases will arise which will show that even the more academic portions of this paper have some real practical application. It may not be obvious, at the moment, what that practical application may be; but the scheme of investigation was carried out consistently with the view of demonstrating what ingredients of road-treating materials were, in extreme conditions, likely to be harmful to fish and what ingredients were likely to be, even in extraordinary conditions, innocuous. Broadly, the investigations show the worst results obtainable with the fish with the particular ingredients stated. In all practical conditions, those results will be modified, in that the fish will not be so liable to premature death. There are several reasons why those modifications will occur, to some of which speakers have alluded. One is that very seldom do road washings reach streams without some sort of filtration and purification by passage through air, or over sand, or in contact with vegetable matter or organic matter, any one of which conditions is destructive of one or other of the harmful ingredients in the tar. In the Author's investigations, the harmful ingredients were used in conditions in which their effect was not minimised in any way. In the practical use of road-treating materials on the road the conditions will certainly minimise the effects, as compared with those shown in this paper. In regard to Mr. Thomas's remarks—and I thank him very much for his appreciation of what I have said—that very few fish are alike in temperament, or the way in which they take the hook, that I, early in these experiments, realised, and wherever doubtful or inconclusive results were obtained I deleted them from the record. I think on the whole the results reported may be regarded as a fair average. I may pass on to the question of keeping fish in unnatural conditions, handling them and putting them into these solutions. There again I realised that the resistance of the fish in natural conditions would be greater, and I think you may,

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on that account, add something on to the time that would elapse before death. But the results between one material and the other are comparable, and in that, I think, you have some definite information. As to the question of the road authorities, and the use of crude tar, if it had been safe in all cases to use crude tar on the roads it would never have occurred to me to make these experiments. Colonel Crompton and others have testified that there is a very wide outcry against the use of tar at all in some places—there is a great deal of prejudice in existence: and I wanted to find out what real basis it had. I know more now than I did when I started the work, and I have come to the conclusion that tar, if reasonably free from ammonia and light oils—as tar complying with the Road Board specification—is in all ordinary conditions absolutely safe. But occasionally a surveyor has, perhaps, been harassed by complaints from local anglers or owners of fishery rights, and he is asked by his Council to put down material which it is absolutely certain will do no harm to the fishing streams. It may happen that the washings from the road pass with very little filtration, or possibilities of oxidation into the fishing waters. In that case he asks for something which will safeguard him still more; and I have indicated what I think will safeguard him absolutely, even in extreme conditions. Filtration, for that in effect is what Mr. Thomas has suggested, undoubtedly reduces very greatly the risk of pollution of streams from the use of crude tar, as does also the obtaining of considerable penetration of the surface of the road. I tried to emphasise in the paper that it was the surface exposed to the action of the water which mattered, and not the quantity of tar material put on the road. It is a question of the proportion of the quantity of water falling on the tarred surface to the area of that surface, and the impingement of the water in the tar, that is, the extent to which water and tar mix. In these experiments, where the tar was agitated vigorously with water, you have an extreme condition which would never be realised in practice. There was a vigorous agitation of the tar with the water for fifteen minutes, and the mixture which occurred of phenolic and other constituents of the tar with water, could not possibly occur in any natural conditions. Of that I am certain. I am much indebted to Colonel Crompton for his remarks, and I think what he has said about the complaints—whether justified or not—which roll in, is

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sufficient reason for dealing with the matter in the paper. I agree that if reasonable precautions are taken in the tarring of roads no deaths of fish arising therefrom are likely to occur. The fish may die from quite other reasons. In regard to the possible sickliness of the fish used in the experiments from handling, or being kept in unnatural conditions, I may say I find no difficulty in keeping trout apparently quite healthy for months at a time, provided the water is well aerated, and I imitated those conditions in making these experiments with trout. I doubt whether many will agree with Mr. Gladwell that if fish do not like tar they must do the other thing, for the tarring must be continued, and the fish exterminated. At any rate, I think if that policy were pursued it would be rather a costly one to the municipal and county authorities concerned. I am very sorry to hear that Mr. Anderson is not comfortable in regard to the use of tar at all, and I would suggest with great diffidence, knowing the conditions in which he is working, that he really should ascertain whether there are not other circumstances which may have been responsible for any fish which have been lost in the neighbourhood of his tarred roads. I know something of the character of the tar which was put down in his neighbourhood, and it is almost inconceivable that any harm resulted therefrom. The county surveyor of Hampshire—Mr. Taylor—spoke to me yesterday and told me that he regretted he would be unable to come here, but that I might say from him that one hundred miles of road in his county had been tarred last summer, and he knew of no authentic case of fish being killed by the use of that tar. I do not speak as an angler; but I think the fishing rights in Hampshire are more valuable than in any other county. That is his testimony, which is only controverted apparently by some unfortunate accident which Mr. Anderson has experienced. Perhaps it may interest you to know that the tar used in Hampshire throughout last summer substantially ranged in composition between the tar referred to in the paper as tar "C" and tar "D." Some of it was very nearly like tar "C," and some more like tar "D." It was all freed tar. In reply to Mr. Boulnois. All the ingredients spoken of are present in tar; some are definitely basic, whereas others are acid. And it is important to know whether it is the basic bodies or the acid bodies which are most harmful to fish. Ammonia is a basic body, and is very harmful indeed. The Road Board specification is

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substantially what I say in the paper, safe, in all ordinary conditions. Some of Mr. Milne's remarks I have incidentally dealt with. The conditions adopted are unnatural, and the ill-effects found will be minimised in practice. But in regard to his question as to the effect of sulphate of ammonia applied to the soil as a manure, naturally, it would not, in ordinary circumstances, be washed into the stream; it would be converted into nitrate by organisms in the soil, and the work of these organisms has also to be taken into account in considering the possible effect of the considerable amount of ammoniacal liquor in crude tar when that gets into streams. If it were not that the washings might pass direct into the stream, without passing through sand or soil, we need not fear using crude tar at all, just as we need not fear to apply sulphate of ammonia to the land. But unless you can be sure of giving the nitrifying organisms a chance there is no doubt ammonia salts are very deadly. Mr. Dryland's remarks bear out the contention that there is a greater risk in the use of crude tar than of freed tar. His case, in which tar macadam was left unrolled, and the washings passed into a fish-pond, illustrates one thing I have said in the paper—that it is the extent of the tarred surface exposed to the action of water which matters. With unrolled road metal you have the largest surface exposed to the washing by rain that you can possibly have. Then again, in the instance cited, the washings passed into a pond, and not a running stream, and concentration might ensue in dry weather. Those are conditions which are most likely to be harmful to fish. In regard to Mr. Wood's question as to the estimation of the phenolic bodies in the extract of tar D with two hundred volumes of water, the amount in this case was so small that it could not be ascertained with certainty. I do not say that the phenolic constituents are the only poisonous ingredients there are in tar, but they are the most easy to detect. The proportions of phenol shown in Table II. were obtained by direct weighing of the phenol, which was put in the water, and were checked afterwards by estimation. But it is an easy matter to estimate phenol in clean water; but when you have an extract of all kinds of other ingredients of tar I know of no very exact method to estimate small quantities of it. I thank you very much for your patience in listening to me.

MR. R. J. THOMAS: It is an interesting subject to me, and I should like to ask Mr. Butterfield what he thinks is the possible

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or probable result of the enormous quantity of lubricating oil which is now scattered over our roads by motor traffic in relation to the question of water pollution. We have a large mileage of roadway now tarred, and anything in the shape of oil falling upon such a surface gravitates to the gutters quickly, and is carried to the streams. Would that accentuate the tendency to fish poisoning? It strikes me that, being oil, you will get a very thick film on the surface of the water, and that must very largely affect the fish life under such film, as it prevents the proper aeration of the water, and this exposes the fish to any disease that may be about.

MR. BUTTERFIELD: I have dealt with this point to some extent in the paper—under the heading of Tar Oils and their Associated Bodies (section 8 (ii.))—when referring to the effect of films of oil in general on the surface of the water. I made some experiments with a heavy automobile mineral lubricating oil and gasoline or petrol. The effects were much less marked than with heavy and light oils derived from tar; in fact, no ill-effects were observed on gudgeon in eight hours with a heavy film of gasoline and in twenty-four hours with a film of the lubricating oil. But the film from such materials, in some circumstances, undoubtedly would kill fish in time. When roads are rendered impervious by tar or asphalte, petrol or lubricating oil dropped on them is more liable to be washed into streams than when it falls on a water-bound and porous road. Hence, indirectly, the impervious road (whether tarred or asphalted) may prove more detrimental to fish life than the water-bound road.

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SPECIAL GENERAL MEETING.

February 9, 1912.

Held in the Caxton Hall, Westminster.

MR. A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Secretary read the notice convening the Meeting.

The several resolutions passed at the Special Meeting at the offices of the Institution on Saturday, the 13th of January, were put, and confirmed unanimously.

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SOUTH WESTERN DISTRICT MEETING.

May 4, 1912.

Held in the Public Hall, Exmouth.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE members were given a cordial welcome by the Chairman and members of the district council.

The PRESIDENT returned thanks for the welcome accorded and paid a tribute to the memory of the late Mr. Lewis Angell, the founder of the Institution.

EXMOUTH: A DECADE OF PROGRESS IN A RESIDENTIAL SEASIDE TOWN.

BY SAMUEL HUTTON, *Member*, SURVEYOR AND WATER ENGINEER, URBAN DISTRICT COUNCIL OF EXMOUTH.

Historical.—Situate at the mouth of the river Exe and consisting of the two civil parishes of Littleham and Withycombe Raleigh, Exmouth claims a prominent place in the ancient history of Devonshire. Two Saxon settlements were said to exist on the site of modern Exmouth as far back as the early part of the eleventh century, and a well-known portion of Exmouth, "Bystock," was included in the great Norman Survey of 1086. From this date it appears to have gradually grown until Leland in his Itinerary of 1549 refers to it as "The fischer tounlet of Exmouth." From this period it became (as it is to-day) a port of some importance and supplied a goodly number of vessels to fight the Spanish Armada. About 1680 shows its commencement as a health resort, and therefore it claims to be

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the oldest watering-place in Devon. Since the early part of the eighteenth century it has gradually grown until now it ranks as one of the principal resorts in the county.

Physical.—Exmouth is partially situated on a peninsula surrounded with water on three sides, and enjoys a remarkably equable temperature, together with the highest sunshine records in the county. The rainfall is extremely low (for Devon), the average being only 28 inches.

Statistics.—Population (1902) 10,489 (1901 census); (1912) 11,963 (1911 census). Area (1902) 5295½ acres; (1912) 5295½ acres. Rateable value—gross (1902) 56,000*l.*, (1912) 69,000*l.*; nett assessable (1902) 51,202*l.*, (1912) 63,951*l.* General district rate—district town wards (1902) 5*s.* 2*d.*, (1912) 4*s.*; district rural (1902) 4*s.* 10*d.*, (1912) 3*s.* 8*d.* Loans Outstanding—Public Health Act (1902) 47,964*l.*, (1912) 41,160*l.*; Water Acts (1902) 84,558*l.*, (1912) 99,820*l.* Roads—main roads (1902) 4 miles 4 furlongs, (1912) 4 miles 7 furlongs; district roads (1902) 50 miles, (1912) 52 miles 2½ furlongs.

It will be seen that the rates have decreased considerably since 1902, and that the amount allowable for borrowing under the Public Health Acts stands at present at 87,000*l.*, possibly a record for a town this size.

Roads.—The roads in the district are typical of the county, the main road running right through the centre of the town, the outside district roads are in many cases narrow Devonshire lanes through most charming country. The cost per annum for maintenance only and tarring is 1300*l.* for district roads, 480*l.* for main roads.

The advent of the motor car has necessitated much road widening work, and the Author has carried out twenty-one improvements at a cost of about 3500*l.*, all of which (except 700*l.*) has been provided out of rates. The greater part of the town district and main roads are tar sprayed or tar macadam. Tar spraying works out at about ½*d.* per yard super for ordinary tar and ¾*d.* per yard super for distilled tar.

Exact costs are kept, and the following is an example of work done from May 1 to June 14, 1911:—

Men employed, five; machine used, Johnson Bros., with Wraithman Brooms. Area covered, 72,292 super yards; using ordinary tar—cost per yard super in pence—tar, 0·29; labour, 0·07; teaming, 0·09; sand, 0·02; total, 0·47; area covered 10,250

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super yards; using distilled tar—cost per yard super in pence—tar, 0·487; labour, 0·125; teaming, 0·15; sand, 0·02; total, 0·782.

Grit for spreading on roads after tarring free at the beach. Area covered in 22 days equalled 3863 yards per day. Area covered per gallon, with distilled tar, 6·17 yards super; with ordinary tar, 7·08 yards super.

Tar spraying has been done in Exmouth since 1904, and the results are excellent. The cost of road maintenance since 1904 has been reduced by 700*l.* per annum.

The Private Street Works Act, 1892, is in force, and usually two or three streets are under construction, generally by direct labour. The 1892 Act works very well in Exmouth, and during the Author's tenure of office (9 years) not one penny has been irrecoverable.

Bridges.—There are many small bridges and culverts in the district which require keen attention. In order to meet the increased traffic, it has been necessary to rebuild entirely two bridges on very important roads, viz. Exeter main road, and Withycombe road. These have been carried out during the past eighteen months, and are of reinforced concrete, designed to carry a 20-ton traction-engine. The details are as follows:—

Withycombe Road—width, 42 feet; square span, 18 feet; skew span, 20 feet; cost, 133*l.*; Exeter Road—width, 42 to 50 feet; square span, 18 feet; skew span, 20 feet 6 inches; cost, 150*l.*

The works were carried out by direct labour under the Author's supervision. The details of cost of the Withycombe Road Bridge are as follows, and include pulling down the old brick arch structure. The concrete was composed of 4 parts beach gravel, 1 of ¾ granite chips and 1 of Portland cement, the structure contains 102½ cube yards of concrete.

	£	s.	d.
Wages	39	1	11
Reinforcement and supervision	38	16	4
Cement, 23 tons	32	13	5
Chips, 31 tons	7	7	3
Teaming including carting of gravel	10	4	9
25 % gross cost of timber	5	9	10
Railing and stays	8	6	1
Tiles, clay for dam, nails, etc.	2	13	1½
Oil and sundries		4	10
	144	17	6½
Less credit, old material	12	0	0
	£132	17	6½

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The gravel (102 loads) was free at the beach. Allowing for this the structure can reasonably be claimed to be an economical one, and the Author is of opinion that few contractors would care to carry out the work for the amount named. These two bridges are illustrated on Plate No. 1.

Sewerage.—The sewerage is on the combined system generally; though where possible storm water is carried into streams direct. There are three systems, low level, middle level, and high level.

The low-level system which drains the lower portion of the town, about $\frac{1}{5}$ of dry-weather flow, delivers to a pumping station containing three pumps, which are operated by two 5 N.H.P. and one 10 N.H.P. gas engines, lifting the sewage into the high-level sewer which gravitates to the outfall in the channel.

The following are the particulars of pumping with working costs for a year:—Pump and engines, two 5 N.H.P engines and pumps used for dry weather flow; gallons lifted, 39,095,300; height of lift, 37·35; length of lift, 580 feet; gas consumed, cubic feet, 279,200; total cost of gas at 3*s.* 5*d.* per 1000 less 15 %, 40*l.* 10*s.* 10*d.*; cost of gas per 1000 gallons in pence, 0·277; cubic feet of gas per 1000 gallons, 7·956.

No. 1, 10 N.H.P. engine and pump used for storm water; gallons lifted, 4,270,327; height of lift, 35·35; length of lift, 574 feet; gas consumed cubic feet, 31,300; total cost of gas at 3*s.* 5*d.* per 1000 less 15 %, 4*l.* 10*s.* 11*d.*; cost of gas per 1000 gallons in pence, 0·255; cubic feet of gas per 1000 gallons, 7·33; total cost per 1000 gallons including wages and maintenance, 0·848 pence.

The low level and high level systems are entirely modern, and were designed by James Mansergh, Esq., and completed in 1902.

The middle level sewer ($\frac{2}{5}$ of the dry-weather flow) except for a short length is some thirty years old, and has been more or less a worry and trouble since it was laid. The attempt to drain the whole of Exmouth by gravitation was a mistake, and frequent flooding occurred. The town muddled through until the new system was brought into use in 1902 and has since been practically free from flood.

It was hoped by Mr. Mansergh that when a certain district was transferred to the pumping zone, the existing outfall by

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gravitation would serve for the middle level district. This hope was never fully realised, and considerable silting up occurred, and until the Author relaid certain lengths of this outfall sewer, and placed large flushing tanks (10,000 gallons capacity) at different points, the sewer was far from satisfactory. The flushing arrangements for this sewer are somewhat unique, and the Sanitary Committee for a time took some persuading to undertake the work. The late Medical Officer (Dr. Eaton) and the Author persistently pressed the proposals, until the Council agreed to apply to the Local Government Board for a loan to carry it out.

There was considerable opposition, but, as the Author stated to the inspector, the only other alternative (with which the Author did not agree) was another pumping system, to cost about 10,000*l.*; the Board agreed to the Council's proposals entirely, and gave the sanction for a ten years' term as applied for. The cost was about 800*l.*, the large flushing tanks costing 75*l.* each. The arrangements of these tanks is shown on Plate No. 2. They are operated by hand, working inwards from the outfall, as the varying tides do not permit automatic flushing at certain levels. The scheme has been an unqualified success, and a distinct saving of over 9000*l.*

The whole of the sewage is discharged into the sea at Maer Rocks, a little inside the Fairway buoy, and the discharge is at all tides.

Refuse Disposal.—The house refuse is collected by the Council's own staff, and disposed of by a refuse destructor, situate close to the railway line, about half a mile from the station. The plant was completed in March, 1908, and the general arrangement of the destructor is shown in Plate No. 3. It is a Meldrum two-cell, front feed. This method of feed, especially for a small plant is, in the opinion of the Author, the most satisfactory.

The plant is exceedingly efficient, and though the refuse is light and of poor calorific value, yet, as the residue (a clinker) is only 16%, it proves that the combustion is carried out effectually. The plant is run ten hours a day for five days, six and a half hours on Saturday, and banked over night and week ends; it is therefore run at only about 40% of its full capacity.

The surplus steam is used for the steam disinfector, electric light for the works and sheds, and for driving the brickworks

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engine and machinery adjoining. The machinery is capable of turning out four million bricks a year, and is run by destructor steam from five to seven hours each day. The brickworks engine is very old and very inefficient, and consumes about 60 lbs. of steam per horse-power per hour.

The steam for the destructor is connected with the engine at the point shown, and so arranged that the brickwork boiler can supply steam along with it, or each separately, as required.

The receipts from this source are 5½*d.* per hour—totally inadequate—but the best terms the Council could make. The brickwork plant breaks down regularly, and on very wet days stops, and the destructor has to blow off steam until they are ready for work.

The particulars for the year ending March 31, 1911, are as follows: refuse destroyed, 3660 tons; clinker, 600 tons, or 16 per cent.

	£	s.	d.				
Expenses:—							
Oils, materials, etc.				27	5	0½	
Wages				135	12	0	
Insurance, rates, etc.				12	19	8	
				£175	16	3½	= 11·54 pence per ton.
Receipts:—	£	s.	d.				
Clinker	30	18	4				
Steam	25	5	0				
Scrap tin, etc. ..	15	7	1	71	10	5	= 4·67 „ „
Nett cost ..				£104	5	10½	= 6·85 „ „

Pleasure Grounds.—The pleasure grounds are Manor Grounds, 4 acres; Strand Enclosure, 1½ acres; Beach Gardens 1¼ acres; Phear Park, 16 acres; Beach Gardens extension ¾ acre; a total of 23½ acres.

Phear Park was laid out and presented to the town in August, 1910, by the family of the late Sir John Phear, a prominent figure in Exmouth public life for many years. The Author carried out the work of enlarging the Manor Grounds to its present area, and also the Beach Gardens, and is now engaged upon its extension. This extension will complete the scheme for sea-front gardens, and is certainly work of an interesting nature.

The new sea wall is to form a promenade and shelter, and is designed on the cantilever principle, as shown in Plates Nos.

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4 and 5. The calculations are based on a promenade load of 2 cwts. per foot sup.

There will be no support to the outer edge of the upper promenade, except at the steps, where it is not practicable to cantilever from the wall. Wind screens will be placed at intervals, and, though only 100 yards long, it will possibly be somewhat unique in sea-wall construction. The estimated cost of this wall is 710*l.*, and will, so far as the Author can see, be carried out for that amount.

The timber for piling is red deal, and creosoted with 10 lbs. of oil per cubic foot of timber. The timber is weighed both before and after creosoting to check the weight of oil forced in.

The whole of the scheme is estimated to cost 1250*l.*, and includes sea wall, laying out, shelter, and underground conveniences for men.

New Streets and Buildings.—The model by-laws are in force, and examination of plans and inspection of buildings is carried out by the surveyors' department. On the average building to the extent of 20,000*l.* is carried out in a year.

Public Conveniences.—Public conveniences are provided in certain parts of the town; they are, however, not equal to the demand, and the Author has placed a report before the Council on the question of further provision being made. An underground convenience for men is being constructed in connection with the Beach Garden extension, taking the place of the existing above-ground structure, which is extremely unsightly.

In the new convenience 9 urinal stalls, 4 w.c.'s, and 3 lavatory basins are provided; the work is being done by direct labour, and will cost about 160*l.*; the doors of the present w.c.'s are to be refixed as well as the roof lights, otherwise everything is new. Plate No. 6 shows the arrangement of this, and the proposed convenience at the Parade.

Sea Defence.—The owner of the foreshore and beach is the Right Hon. Lord Clinton, and he is responsible for the sea defence alongside the main promenade.

Erosion and subsidence of the cliffs and beach has been very considerable during the past eighteen months, destroying entirely the commencement of the charming cliff paths. The Council are responsible for the surface of the path, but disclaim responsibility for the protection of the cliff supporting the path. The Author has reported twice on the subject of protection,

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and submitted to the Council a design of a sea wall (see Plate No. 7), to cost about 12*l.* 10*s.* per yard run, and for sloping back the cliffs to angle of repose, say of 1 in 1½. To protect the whole length would cost about 12,000*l.* The Council immediately referred the report and scheme to Lord Clinton. His Lordship has also had a report and scheme from W. T. Douglas, Esq., M.Inst.C.E. In general design it coincides with the Author's suggestions. At present the matter is awaiting the decision of Lord Clinton.

Near the sewer outfalls erosion of the sandbanks has exposed the manholes and placed the sewers in danger. The Author, after the extreme gale and high seas of December 18 last (when all the damage was done), immediately placed around one manhole a retaining wall, and built up a breakwater of concrete in bags around another. This has been very effective, but it is feared that considerable further expenditure will have to be incurred, as the erosion continues every spring tide.

Town Planning.—A preliminary Town Plan on the 6-inch scale along with a report from the Author has been submitted to the Council, but further consideration is deferred for the present. Part of the town is already developed on good town planning lines, but this is only a high-class residential district. A properly developed town plan must provide for all classes of property.

The town is practically surrounded by roads upon which excellent highways could be developed, and in many ways the district is one which forms an excellent opportunity for developing a large district of exceptional beauty on good lines.

Waterworks.—A paper was read by the Author at the Annual Meeting at St. Pancras in June, 1909, in which the existing waterworks were fully dealt with, and it is not his intention to say much under this head, except that the supplementary supply (to be used only when the gravitation works fail) foreshadowed in the paper has become an accomplished fact, and the works are to be visited after the reading of the paper. A short description of the new works is as follows: they are situated at Dotton, eight miles north-east of Exmouth.

The works carried out consist of bore hole varying in diameter from 25 inches to 7 inches, 338 feet deep, pumping

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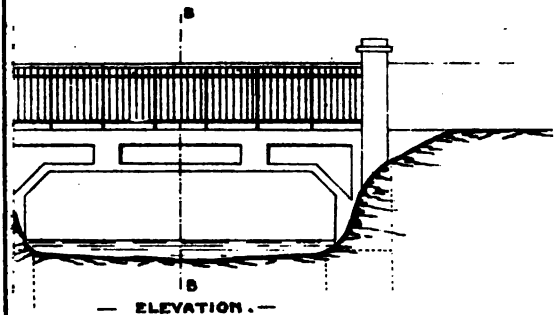
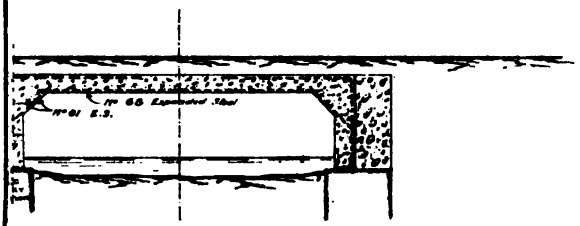
WITHYCOMBE ROAD BRIDGE.

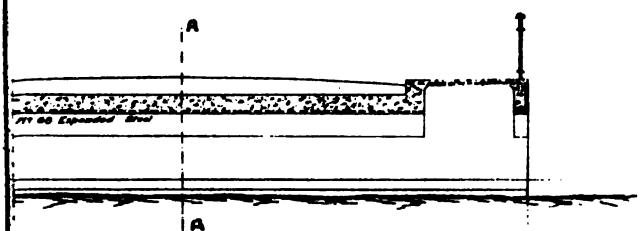
PLATE No 1.



— ELEVATION. —



— SECTION AA. —



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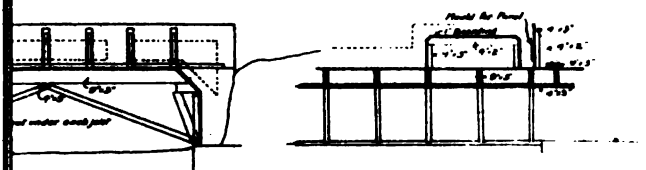

— DETAILS OF TIMBERING. —

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station, pipe line (rising main) 4⅞ miles long to Squabmoor, and reservoir 4 miles north-east of Exmouth.

The pumping plant consists of suction gas engines in two units, each of 62 B.H.P. on anthracite coal; three-throw ram pumps in two units to lift from suction tank to Squabmoor.

The air lift plant is in duplicate to force water from bore hole to suction tank.

The duty of the pumps is for each unit to lift 18,600 gallons per hour against a head (including friction) of 290 feet, through 4 miles of rising main, coal consumption not to exceed 1 lb. of anthracite coal per B.H.P., coke consumption 1 ¼lb. per B.H.P.

Bore Hole.—The bore hole is of a total depth of 338 feet, and varies in diameter from 25 ins. at the top to 7 ins. for the bottom 7 feet; it is made through varying layers of sand-gravel, and new red sandstone until it reaches the pebble beds into which the bore is taken 36 feet. The construction was tedious, the principal delay being the loss of a tool for many weeks in the bottom of the bore. Many other minor difficulties arose, but eventually the pebble beds were reached after nearly ten months' work. The pumping test showed remarkable results, and there is available for use at least one million gallons a day if required.

The bore hole is lined for the first 50 feet down with plain steel tubes, and with the exception of about 35 feet near the bottom, the rest of the lining tubes are perforated.

The cost of the work is as follows:—

		£	s.	d.
Bore Hole	Carriage of plant	40	0	0
	Boring of various sizes, 338 feet deep ..	643	14	8
	Lining of bore hole	647	14	0
	Pumping test	231	14	0
	Sundry items	42	12	0
	Supply of about 3⅜ miles of 12-inch main and 1¼ mile of 9-inch main with valves and washouts	5,532	0	0
	Laying of pipe line	1,623	8	0
	Engine house and approach road ..	1,472	1	1
	Supply of pumping machinery, air lift plant, including small pumping plant at Dotton Farm	2,852	12	0
	Venturi meter	182	4	0
		£13,267	19	9
	Other items, as engineering fees, legal expenses, clerk of works wages, will amount to say	1,250	0	0
	Total cost (approximate)	£14,517	19	9

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The whole of the land and wayleaves have been given free by Lord Clinton, the owner of the property through which the works are carried. The consulting engineers for the scheme are Messrs. G. H. Hill and Sons, Westminster and Manchester.

Conclusion.—The foregoing illustrates the varied work that has to be undertaken now by the average municipal engineer and surveyor, and though the schemes under review are comparatively small, yet the engineering principles involved and problems to be solved are quite as great as much larger works.

The Author takes this opportunity of expressing his indebtedness to the members of his staff, Mr. J. C. Matthew, A.M.I.C.E., and Mr. G. Ponsford, for the great assistance rendered in the preparation of the paper and plates.

DISCUSSION.

MR. E. N. SAUNDERS: I notice that the cost of maintenance and tarring of main roads is given as 480*l*. I should like to know whether Mr. Hutton gets the whole of that repaid to him by the County Council. Then there have been, according to the paper, twenty-one widenings of roads. Do you get paid for any of the widenings of main roads?

MR. H. T. CHAPMAN: I should like to take this opportunity of expressing my thanks to the members in the south-western district for the honour they have done me by my election as district chairman. I am sure I shall do my utmost to promote the interests of the institution in general and of the south-western district in particular. It is too early yet to put forward any programme or indicate any line of action, but no doubt we shall soon have a meeting of members of the district to discuss various matters. I should like to ask Mr. Hutton one or two questions on his paper. Being interested in road maintenance I naturally looked at that portion first, and noticed that the cost of the main roads is put down as 480*l*. for 4 miles, 7 furlongs, which works out at about 98*l*. per mile. I should like to know whether the county council allow the whole cost of the main roads, including scavenging. In regard to tar-spraying it would be interesting to know the prices of ordinary and distilled tar, no mention of which is made in the paper. The cost

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of the tarring of the roads is extremely low, but it has to be remembered that Mr. Hutton gets his shingle practically for the haulage, which reduces the cost of the work. Then the area covered per gallon is rather high, 7·08 yards super. I think about 5 yards is ample. I should like to know whether there have been any accidents due to the surface tarring. I notice the camber of some of the roads appears rather high. I particularly noticed Rolles Street; with a less camber on the roads they would be less dangerous to traffic. I am somewhat interested in the Withycombe Road bridge, and I have one or two questions in regard to it. What size is the aggregate of beach gravel used in the reinforced concrete? and also what make of cement was used; the price of the cement works out at 28*s.* 6*d.* per ton, which is very low indeed. Then the cost of the timbering, 5*l.*, is very low. I presume that must be the wastage on it? [MR. HUTTON: Yes.] I would like to know what was done while the bridge was being built, because there is no mention made of the traffic. Was the road closed to traffic or a temporary bridge built? The paper states that 102 loads of beach gravel were free; what was the cost of the concrete used in the work per cubic yard?

MR. J. PATON: I have much pleasure in proposing a vote of thanks to Mr. Hutton as the author of this paper. I think we must all agree that a good deal of very useful information has been given us in the paper. Exmouth has a charm of its own, and I have been struck when visiting the town by the sanitary arrangements and the excellent methods adopted in cleansing. The streets are excellently kept and every public service appears to me to be just as well ordered. There is another point which has struck me in reading this paper, and that is the system you have adopted of doing most of your work by direct labour. I think you are right in that direction. It is difficult often for surveyors to get their councils into line to do many of those works which you are now doing by direct labour. Private street work is particularly a work which ought to be done by the authorities themselves. Streets have to be taken over and maintained afterwards as highways, and it is essential that the roads, in the first instance, should be so made as to last a number of years without becoming a charge upon the rates. Mr. Chapman has referred to one matter the cost of which struck me as being particularly low—the tar-spraying of the

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roads. The tar-spraying which I have done has cost me considerably over 1*d.* per yard. I congratulate Mr. Hutton on the low cost at which he does that work. The information is very fully given and exceedingly valuable. I am quite sure, in visiting these smaller towns and viewing the work carried out by the surveyor and engineer to the authority, one cannot help feeling that they have their difficulties even to a greater extent than the engineers of larger authorities. In large towns you have a high rateable value to draw upon, and can deal with schemes with a freer hand and in a bolder way than in the smaller towns, where probably 100*l.* or 200*l.* means a penny rate. I do not know what a penny rate amounts to here?

THE CHAIRMAN OF THE COUNCIL: 230*l.*

MR. PATON: That being so, the engineer must always bear in mind that he must, consistent with proper design and good work, bring forward a scheme at low cost, and, having regard to that, greater knowledge and skill are required than in some of the larger schemes.

MR. H. A. GARRETT: I rise with very great pleasure to second the vote of thanks. I see Mr. Hutton says Exmouth has the highest sunshine record in the country. In order to justify this statement, I think it would be an advantage if you would put in the paper the official figures showing the actual number of hours of sunshine for reference. It is highly satisfactory to the ratepayers to find the rates are decreasing. Having regard to the difference from that of 1902 I would like to know whether the basis of assessment is the same now as then, or has there been any revaluation which has increased the assessment, thus reducing the rate, but the amount payable on properties remaining the same, although the rate per £ has been reduced? I would also like to know what the words "maintenance only" cover. If that means only road repairs I am satisfied, but if it is to cover all other contingencies, such as scavenging, sweeping, watering, cleansing, and flushing gulleys, it is rather a low figure. With regard to tarring, I think it would be well, in arriving at the cost of the tarred roads, to add the estimated value of the shingle and sand used. Since 1904, when tar-spraying was adopted in Exmouth, the cost of road maintenance has been reduced by 704*l.* a year. That is a very big proportion of the total cost. When one looks at a beautiful town like Exmouth, its flat roads, no gradients any

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where, and very little traffic, it makes one a little envious. I must congratulate Exmouth upon the excellent way in which the town is kept. Tar-painting is a splendid dust palliative, and in a district like this saves an enormous amount of money in repairs. In Torquay, however, I am somewhat handicapped in this connection owing to the hilly nature of the town, and I am obliged to watch every inch of road on the hilly gradients. If I go two inches too far with my tarring I get every cabman in the town complaining, horses down and a lot of accidents, and have to take it up again. I think other surveyors have had similar experience. I think you have adopted the right principle in doing a good deal of your work by direct labour. I have had a good deal of experience of this method and also of contractors, who naturally want to make a good profit on the job. If you make a fair estimate, and do the work conscientiously and well by direct labour, the town gets the advantage.

MR. CHAPMAN: There is just one other question I wish to ask—that is whether Mr. Hutton can tell us to what extent the cost of his scavenging has been reduced in consequence of tar-spraying, and whether the amount of watering has been diminished, and therefore the cost.

MR. H. A. GARRETT: In connection with tar-spraying, I should like Mr. Hutton to give the wages per hour paid to the workmen.

MR. E. N. SAUNDERS: I should like to ask whether you take trade refuse under the ordinary collection, or do you take it by any special arrangement.

MR. D. EDWARDS: I notice that the waste heat from the destructor is used for supplying steam for the disinfector, electric light for the works and sheds, and for driving the brick-works engine and machinery adjoining. In the expenses there is nothing put down for coal, although there is a certain amount of coal used for the damping down every night. I should like to know whether any coal is used for the purpose of increasing the heat. I know destructors which have been put up for creating heat, and failed to pump sufficient water for their own boilers. I do not know whether you find that in Exmouth. If you do, the cost of the coal used should be included in the expenses.

MR. J. SIDDALLS: I should like to emphasise the fact that

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Mr. Hutton is in a most advantageous position as regards his tar-painting. At Tiverton we have to pay 7*s.* 6*d.* per ton for all our sand. That runs our price up to 0·98 of a penny per yard. I should like to ask Mr. Hutton if he has any cost in connection with the sand. He must draw it.

MR. HUTTON: It is included in the paper—labour and teaming.

MR. SIDDALLS: Since Mr. Hutton has been here he has greatly improved the streets in that respect. He has gradients here, though not so steep as Torquay. What is the maximum gradient he is able to tar here? The surfaces of the streets in Torquay and in Exmouth are very largely different, owing to the different kind of material used.

MR. R. STEPHENS: I should like to ask what material Mr. Hutton uses for the roads?

MR. GILBERT PHEAR: I belong to the Public Works Department of India, and in the Roads and Building part of that department our work is very similar to that of the municipal engineer in this country. I have read Mr. Hutton's paper with great interest, and I hoped in the course of the discussion I should be able to pick up some crumbs of information. Our conditions in India are very different; our climate is different; our materials different, and our labour entirely different. We are very much handicapped in not getting the material you have at home. In concrete work the price of the cement is so great that we cannot use concrete at all, except with big and expensive works. If works have to be carried out with concrete, we have to import it all from England. May I be permitted to ask one or two questions on the paper? As regards the beach extension wall, do you intend to use any waterproofing medium in your concrete? because, it seems to me, there might be some trouble from dampness passing through the wall from the earth behind and interfering with the comfort of the people who have to use the seats below. I am speaking from my experience in India, where our rainfall is very high. I should also like to ask the method of fixing the cantilever in the sea wall, and whether you intend to use any netting or anything of the sort to prevent children falling over the edge.

A Member: Can you give us the price per ton of cement in India?

MR. PHEAR: I do not know that I can tell you that. We

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import it in barrels, and it works out, up country, at 15 rupees (1*l.*) per barrel of 4 cubic feet.

THE PRESIDENT: The paper is full of very interesting facts, and there is an advantage, as Mr. Hutton has said, in leaving out a lot of detail which is not necessary in a paper such as this. There is no doubt it is necessary that you should have a good water supply, a thoroughly good system of drainage, that you should keep your town thoroughly clean, and provide for all the comforts of visitors. I think that is done excellently in Exmouth. The question of tar-spraying seems to have been a debatable point. There, again, it is necessary to consider the various factors which make up the total amount. I cannot in my town get tar-spraying done for less than 1¼*d.* per yard. We have to pay for all the gravel and sand we use, and pay heavily in some respects. You cannot compare the cost of roads unless you go into all the questions of traffic and so on. Where traffic is heavy, as in manufacturing towns, the cost must be higher.

The vote of thanks having been accorded,

MR. S. HUTTON, in reply, said: Mr. Saunders asks what proportion of the cost of main roads we get from the County Council. For the last seven years I have got within 10*l.* of what they have cost. Practically the county pays for the whole of the main roads here—maintenance, scavenging, and everything. We have a contract with the County Council for 610*l.* a year. If we carry out the work for less than 610*l.*, we gain by it; if it costs us 620*l.* the next year, we average it. We have nothing to grumble about so far as our main roads are concerned. As to the widening of main roads, I get one half, except where property is purchased. Then the County Council allow one-third. I collect traders' refuse for 1*s.* 6*d.* per load, or destroy it for nothing if taken to the destructor. We do not get more than six loads a year.

Mr. SAUNDERS: How is the cost of the land for widening roads calculated?

MR. HUTTON: Any property I have to purchase I get one-third of the actual cost, and one-half of the cost for the engineering works. The 480*l.* for main roads is the actual maintenance; the difference between 480*l.* and 610*l.* is what is spent on watering and scavenging. The price of crude tar is 2*d.* per gallon, and distilled tar 3*d.* I have had no accidents

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and no complaints for three years. As regards the camber of the roads, that is the one thing I object to in Exmouth. When they began to make the roads they carried them out in accordance with the model by-laws. With a high camber the traffic goes in the centre of the road, the wear is in the centre, and all the repairs are there, with the result that the camber is further increased. I am making 29-feet carriageways, with a 6-inch rise in the centre, and I shall not have to increase the camber on that, as the traffic will be distributed over all parts of the road. For the work at Withycombe Road bridge, the size of the gravel varied from inch- to pea-size, with a good deal of sand. The cement was the best Portland at 28*s.* 6*d.* per ton. The contract was made in the January previous. The 5*l.* 9*s.* 10*d.* allowed for timber is the actual loss on it. I have used most of that timber two or three times since in timbering for sewers. I do not think it is fair to charge 20*l.* for timber when it is usable again. The bridge was closed for traffic. I had a private road close by, which the owner allowed me to use by arrangement. The cost of the concrete, without reinforcement, worked out at about 12*s.* 6*d.* The cost of the scavenging has certainly been reduced. It is now no greater than it was nine years ago, and since then we have put up six hundred or seven hundred houses. With the additional streets we do the scavenging at the same price as formerly. There is also a saving as regards watering. When the roads were ordinary macadam, I used four water-carts; now I use only one for the hilly roads which I cannot possibly tar. I have been stopped taking grit from the foreshore. This has caused me a good deal of anxiety, therefore I have lately been using chippings at 5*s.* 3*d.* per ton, which adds 0·33 of a penny to the cost, which brings it up to 0·88 of a penny. If you will take the price in the paper and add 0·33 for the chippings to it you will have a figure for comparison.

MR. CHAPMAN: There is nothing allowed for plant.

MR. HUTTON: It is all done by hand. I use Wraithman's brooms mostly, covering with them easily some three thousand yards a day with five men. I will give Mr. Garrett the sunshine record for 1911—it was 2098⅞ hours, to be exact. Mr. Garrett raised a point about the rateable value. You know what credit a surveyor takes about the lessening of the rates. We have had no revaluation to any extent, but the rateable

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value has increased each year, about 1200*l.*, which is considerable for a little place like Exmouth, and it has helped us considerably.

MR. PATON: That is the natural increase?

MR. HUTTON: Yes. The wages of workmen are fairly low, about 4½*d.* per hour. In answer to Mr. Edwards as regards the destructor, I have not used an ounce of coal since it was started. I can, however, always tell what district we are using the refuse from. I find when we are doing well and raising steam freely the refuse is from New Street, an artisan district. The poor are not half so careful of coal as the better-class people. We can always do much better with New Street refuse than with refuse from Douglas Avenue, which is our wealthy district.

MR. EDWARDS: May I ask if you start your furnace without an ounce of coal.

MR. HUTTON: We only start with some light refuse.

MR. GARRETT: We start in the same way.

MR. HUTTON: I do not let the fires go out more than once in three months. Then the carters have instructions to bring in some light and dry refuse, and they know exactly what to collect. As to gradients, I believe I have a gradient of one in ten tarred.

MR. GARRETT: What is the traffic?

MR. HUTTON: The ordinary traffic. The material used on the side road is limestone from Babbicombe Bay, which costs 4*s.* 2*d.* per ton at the docks. The greater part of the stone is from the Manacles. It is really a first-rate stone, and I get it delivered into Exmouth at 8*s.* per ton.

MR. PATON: What quarry, St. Keverne, or the Dean quarry?

MR. HUTTON: Both quarries. Mr. Phear asked what waterproofing material I am using for the sea wall. The only waterproofing I am doing is asphalting the top of the promenade. The Local Government Board asked me to do that. With the Exmouth material I can make a waterproof concrete without rendering. On the filter beds it did not sweat through centre walls with 7 feet head of water on the other side.

THE PRESIDENT proposed a vote of thanks to the Chairman and Members of the Exmouth Urban District Council for the use of the room for the meeting, and it was heartily accorded.

The Members then proceeded to inspect the extension of the Beach Gardens.

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The Chairman and Vice-Chairman of the Council entertained the Members to luncheon at Thorn's Hotel. The Chairman of the Council (Mr. H. Blackmore) presided.

In the afternoon the Members drove to the Dotton pumping tation, calling on the way there at the filter beds and reservoirs.

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MIDLAND DISTRICT MEETING.

May 11, 1912.

Held in the Law Courts, Nuneaton.

R. J. THOMAS, M.INST.C.E., VICE-PRESIDENT, *in the Chair.*

THE Mayor (Councillor T. Horton, J.P.) and members of the Corporation offered the Members a very hearty welcome to Nuneaton.

The Chairman proposed, Mr. Richardson seconded, a cordial vote of thanks to the Mayor and Corporation for their kindly welcome, and for the use of the room for the purposes of the Meeting. This was carried with acclamation.

A letter from the President was read. Mr. Greatorex regretted his absence from the meeting. He was attending the funeral of the late Mr. J. T. Eayrs, Past-President.

A sincere vote of sympathy was, on the motion of the President, seconded by Mr. Clarson, unanimously passed to the family of the late Mr. Eayrs.

TEN YEARS OF MUNICIPAL WORK IN NUNEATON.

BY F. C. COOK, ASSOC.M.INST.C.E., *Member*, BOROUGH ENGINEER AND SURVEYOR.

A DISTRICT meeting was held at Nuneaton in October, 1901, at which a paper descriptive of public works was read by the Author's old chief and predecessor, Mr. J. S. Pickering. It is

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therefore only necessary to refer in detail to recent developments, and to works which have been carried out in the intervening ten years.

Although the name Nuneaton is derived in part from a nunnery founded here by Robert Earl of Leicester in King Stephen's time, the town is essentially of modern growth. Geologically it is situated close to the outcrop of the coal-measures forming the Warwickshire coalfield, and this, coupled with excellent railway facilities which have led to the establishment of many and varying works and factories, mainly accounts for the commercial importance of the town to-day.

Nuneaton was incorporated in 1907. In point of area it is one of the largest boroughs in the Kingdom; but more than one-third is comprised within the Arbury Hall Estate—the "Cheverel Manor" of George Eliot's "Scenes of Clerical Life."

STATISTICS.

Area of the borough			10,596 acres
Population	1901, 24,996	1911,	37,083
Rateable value	1901, 108,011*l.*	1911,	152,157*l.*
Number of inhabited houses	1901, 5122	1911,	7704
Persons per house	1901, 4·88	1911,	4·81
Birth rate	31·2		
Death rate from zymotic diseases,	2·00		
„ „ other causes	9·80		
Total	11·80		

Penny rate produces 580*l.* to the Borough Fund, and 480*l.* to the General District Fund.
Average rainfall for last ten years, 22·74 inches.
Levels above Ordnance Datum: 530 feet to 262 feet.

HIGHWAYS.

There are 42⅛ miles of public highways within the Borough, of which 10¾ miles are main roads, in respect of which the County Council pay the Corporation the sum of 2100*l.* per annum. The surfaces of all roads over railway and canal bridges, and the approaches thereto, are also maintained by the Corporation under Agreements with the various Companies concerned.

Stone Quarry.—The stone used for highway purposes is a quartzite, obtained from the Corporation Quarry at Tuttle Hill. The plant comprises a Broadbent 16-inch by 8-inch breaker and 22-inch by 12-inch roller mill, with the necessary elevators

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and screens, driven by a 12 N.H.P. high-pressure semi-portable steam engine. The annual output is about 12,000 tons and the cost of production, of all material, is about 2*s.* 3*d.* per ton, exclusive of establishment charges.

Construction and Tar Spraying.—Tar macadam has been used to a certain extent, and trial has been made of other compounds, such as "Rocmac" and "Glutrin."

Tar spraying has been carried out successfully, and last year the length of roads treated was eight miles. Two hand-spraying machines were used, and the cost was as follows:—

T.	C.	Q.		£	*s.*	*d.*
100	15	2	Crude gas tar at 29*s.* 6*d.*	148	12	10
18	9	2	„ „ 30*s.*	27	14	3
359	13	0	Granite chippings, 2*s.* 9*d.*	49	9	0
			Labour	95	15	9
			Cartage	73	19	0
			Sundries	2	8	11
				397	19	9
			Add 10 per cent. for supervision, use of plant, etc.	39	16	0
				£437	15	9

Total length treated—13,962 lineal yards = 7·53*d.* per lineal yard.
„ area „ 107,692 square yards = 0·97*d.* „ square yard.

The Author has found tar-spraying successful as a dust preventive under almost all conditions; and in the case of outlying roads, where the traffic is light and the surface has the full influence of sun and wind, it fulfils an added purpose in prolonging the life of the road.

Other palliatives for dust, such as chloride of calcium and "Akonia," are used on streets in the centre of the town which it is not considered advisable to tar-spray.

Monetary considerations render it almost impracticable to take in hand the reconstruction of the highways in such a manner as to fit them for the requirements of present-day traffic; but an expenditure of something like 40*l.* a mile year after year, with the sole object of dust prevention, and without any prospect of effecting permanent improvement to the highway, appears a particularly uneconomical way of dealing with the matter.

Concrete Slabmaking.—Nearly the whole of the concrete slabs required for footpath paving are manufactured at the depôt, washed granite chippings, from the Corporation Quarry,

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being used for the purpose. They are all made 2½ inches in thickness, and cost about 2*s.* 1*d.* per square yard, exclusive of establishment charges.

Street Improvements.—Nuneaton is obviously a town laid out with no regard to future development. The sum of 15,000*l.* has been spent within the last ten years in street widenings—largely in improving the approaches to the Market Place, and important improvement schemes are still in hand. Every opportunity is taken to widen and improve arterial roads through land likely to be developed for building, and in this connection it is gratifying to record the reasonable manner in which, generally speaking, property owners receive the proposals of the Corporation.

Public Slaughter-Houses.

Public slaughter-houses were erected in 1909 as the outcome of a refusal of the Council to grant licences for private premises in the town proper. The project was strongly opposed by the local Master Butchers' Association; but upon the scheme receiving the sanction of the Local Government Board, these gentlemen placed their experience at the disposal of the Sanitary Committee, and gave valuable advice as to the construction and equipment of the buildings.

The site selected is midway between the London and North-Western and Midland Railway stations, and possesses the advantages that it is possible to lay on steam to the buildings from the boilers at the sewage pumping station, and to utilise an adjacent railway siding. It was decided to construct the buildings in complete and distinct sets comprising lairage, yard, and slaughter-house, and to let each set to separate tenants, rather than to adopt the usual type of a common slaughter-hall. The former method is doubtless less convenient, from the meat inspector's point of view; but it ensures privacy, as between different butchers, and fulfils generally the objects of the local authority.

The lair for each set is 18 feet by 18 feet, with wrought-iron fencing for sheep and cattle, the intervening open yard is 12 feet in width, and the slaughter-house is also 18 feet by 18 feet, and 16 feet in height to the wall plate, with hoisting tackle and other necessary fittings. The buildings are all paved with

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cement concrete *in situ*, with herring-bone grooves to the drainage channels. There is a covered way, 18 feet in width, on the outlet side of the slaughter-houses common to all the buildings.

The site is large enough to accommodate eight sets of buildings. Three sets were erected in the first place at a cost, including all fittings, of 1703*l*. Each set is let at a rental of 21*l*. per annum, with a separate charge for electric light, the tenants being held responsible for the cleanliness of the buildings.

Smallpox Hospital.

The Nuneaton and District Joint Hospital District comprises the Borough, the Urban District Council of Bulkington, and the Rural Districts of Atherstone, Foleshill, and Nuneaton, and was formed for the purpose of provided a smallpox hospital. A site was purchased at Bramcote, just outside the borough boundary, and the buildings were erected from the Author's designs in 1907.

The cost was as follows:—

	£	s.	d.
Administration Block	1203	16	2
Ward Block (16 beds)	1437	19	3
Observation Ward (4 beds)	642	15	0
Laundry Block and Machinery	969	19	7
Caretaker's Lodge	376	0	0
Fencing	259	0	0
Water Supply and Drainage	417	15	5
Roadmaking and Laying out Grounds	256	14	7
Legal Expenses, Clerk of Works, etc.	369	16	7
	£5933	16	7

In designing the hospital administrative provision was made for forty beds.

There is nothing noteworthy in the design of the buildings, except that the discharge block, comprising undressing room, bath room, and dressing room, is part and parcel of the administration block, although provided with separate entrances. The buildings generally are of local red bricks, with artificial stone dressings and tiled roofs. The infected buildings have maple floors, with a glazed brick cove at the junction with the floor, and all angles are rounded. Town water is laid on to the buildings: but sewage is treated on the site, by means of a

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small circular percolating filter fitted with a water-wheel distributor.

No case of smallpox has occurred since the erection of the hospital. The Sanitary Committee of the Town Council are desirous of utilising the buildings as a sanatorium for phthisis cases; but there appears to be some objection to this course on the part of other members of the Joint Committee.

Public Baths.

On account of the expense of maintenance no steps have been taken to provide permanent swimming baths: but the needs of the public in this direction have been supplied in a reasonably effective and less expensive manner.

A set of slipper baths, nine in number, has been installed in an unused building belonging to the electric committee. The partitions are of deal, with the framework let into cast-iron sockets fixed in the tiled floor, and the baths are of enamelled cast iron, with hot and cold water laid on. The electric department supply the steam required for heating the water at a charge of 16*l.* per annum. Last year the baths were used by 11,367 persons; the charge for admission is 3*d.* each, and the loss on the year's working was 28*l.* 8*s.* 3*d.*

First and second-class open-air swimming baths have been formed by the conversion of two disused circular sewage precipitation tanks, 80 feet in diameter. The floor is formed of cement concrete, sloped to give a depth varying from 3 feet 6 inches to 6 feet. The first-class bath is provided with dressing boxes, fifty-four in number. The water for filling the baths is pumped from the river; a constant circulation is maintained, and each bath is emptied and cleaned once weekly. The water is heated by an injection of steam from the boilers at the adjacent sewage pumping station. The baths were open last year for a period of twenty-one weeks; the admissions numbered 16,339, at a charge of 3*d.* and 1*d.* (with a reduction for children) for the first and second-class baths respectively, and the loss on the year's working was 17*l.* 18*s.* 2*d.* The cost of construction was defrayed from revenue, and amounted to 550*l.*

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Flood Prevention.

The river Anker, which passes through Nuneaton, is a tributary of the river Tame, and joins the latter river, after pursuing an extremely tortuous course, at a point twelve miles north-west of the town. The area of the watershed above the town is 29½ square miles, and the subsoil is mainly a stiff marl, so that the proportion of rainfall reaching the watercourse is unusually high. As the result of its geographical position, the town has always been regarded as liable to flood; but probably nothing so disastrous has occurred as on the last day of the last century, when, as the result of a rainfall of 2·83 inches in twenty-four hours, the centre of the town was under water to a depth of nearly 3 feet, and the area of the built-on portion submerged was 200 acres.

Various remedial measures were considered, including the improvement of the existing watercourse, the construction of an impounding reservoir, and the formation of a relief channel to the river, from above to below the town. In order to test the legal position of the Council, application was made to the Local Government Board for sanction to a loan for improving a short length of the river. The application was refused on the grounds that no statutory authority existed empowering expenditure for such a matter; the Council at that time were unwilling to incur the expense of obtaining a private Act, and the question remained in abeyance.

However, on October 28, 1903, the matter was again forced to the front. On this occasion, 0·95 inch of rain fell between midnight and eight o'clock in the morning, following three previous wet days, bringing the total rainfall to 1·81 inch. The river rose to such a height as to touch the under side of a girder footbridge in the centre of the town, and there were fears that a flood was imminent.

This rainfall was in no way abnormal. From records made at Coventry, 9 miles south-west of Nuneaton, it appeared that on forty-nine previous occasions since 1868 a rainfall of 1 inch in twenty hours had been exceeded, whilst on twenty-two occasions it had exceeded 1½ inch in twenty hours.

The Council thereupon resolved to promote a Bill in Parliament authorising the execution of works of flood prevention. The scheme adopted involved the re-construction of two obstruc-

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tive masonry bridges, the straightening of the river course, and the cleansing and grading of the river bed, the object being to increase the velocity of flow through the town by improving the hydraulic gradient, and prevent backing up from below. The length of river affected was 3 miles.

The Act constituted the Council conservators of the river, and the work was put in hand immediately Royal Assent was given. It was the original intention to increase the sectional area of the river channel throughout to 272 square feet; but this was afterwards modified to coincide with the sectional area of the existing channel in the town, viz. 206 square feet, which it was calculated would effect a reduction of the surface level as compared with that of the river when running full under the old conditions, of 3 feet.

The construction of a relief arch to an existing masonry bridge carrying a main road was carried out by and at the expense of the County Council. The cleansing and grading of the river bed was undertaken by Messrs. Bomford and Evershed, of Evesham, who utilised a steel scoop about 8 feet by 3 feet, which was drawn from side to side of the channel by means of a traction engine on one bank, working round a pulley wheel fixed on the other. The remainder of the work was carried out by administration.

The cost of the work executed, amounted to 4000*l.*, whilst the expense of obtaining the Act (to which all opposition was withdrawn before the hearing by Committee) was 1155*l.* Having regard to the fact that the works sanctioned were entirely unconnected with a profit-earning undertaking, the Parliamentary expenses appear out of all proportion to the authorised expenditure on the scheme itself, viz. 10,000*l.* Such a condition of things is an unpleasing commentary on our methods of local government, and must tend to retard the execution by small authorities of work, very necessary of itself, but which may not happen to come within the purview of the Public Health Acts.

So far as one can judge, the work executed has achieved the object in view. Thus, on November 28, 1910, the water in the river rose considerably and flowed through the town in exactly the same volume as on October 28, 1903 (prior to the execution of the work), but with a reduction in surface level of 2 feet 10½ inches—practically the result aimed at. Also, on

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the latter date, as the result of 1·67 inch in three days, the river rose 3 feet during thirteen hours after rain had ceased to fall; whilst in November, 1906, under practically similar conditions as to rainfall, the river continued to rise for two hours only, and then to a height of but a few inches.

Every effort is made to collate reliable data with respect to the effect on the river of varying conditions as to rainfall, and the existence of a mill weir, 40 feet in width across the stream just above the centre of the town, affords excellent opportunities for the purpose. The depth of water flowing over the weir is automatically recorded, and compared with the rainfall diagrams, the results tabulated, and sections plotted showing the maximum height of water in the river under abnormal conditions. It seems impossible, however, to set up any definite relation between the rainfall and the flow of water in the river. It is obvious, for instance, that an inch of rain falling upon a frost-bound surface, or already saturated sub-soil, would have a very different effect to a similar rainfall in the summer months, and that the whole question depends in a great measure upon pre-existing conditions which cannot always be taken into account, such as the degree of saturation of the sub-soil, the condition of the river channel and its tributary streams, and so on.

The observations recorded tend to show very little, but that a given rainfall, which on one occasion gives rise to no apprehension, may, on another, almost cause a flood.

Electricity Works.

The undertaking was purchased from a private company in 1900. The plant then consisted of two 75 kw. steam dynamos, and two Davey Paxman loco-type boilers, and the supply was given on the two-wire system with overhead mains at 220 volts.

The capacity of the present plant totals 750 kilowatts, made up as follows:—

One 200 kw. Willans-Siemens steam dynamo.
One 200 „ Willans-Phœnix steam dynamo.
One 150 „ Willans-Johnson and Phillips steam dynamo.
One 200 „ Belliss-Parker steam dynamo.

There is also a chloride battery of 250 cells, having a discharge capacity of 600 ampere hours at the 10-hour rate. A

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new balancer by the British Thompson-Houston Co., Ltd., and a new booster by the Electric Construction Co., Ltd., were installed last summer.

The boiler-house plant comprises three Babcock and Wilcox, and one Danks water-tube boilers with a Green's economiser of 192 tubes.

The water for boiler-feed purposes is drawn from the river by an electrically driven Gwynne centrifugal pump, and is first treated by means of a softener, the hardness being reduced from about 20 degrees to 6 degrees.

Extensions are now being carried out at an estimated cost of 10,000*l.* These comprise extensions of the present engine-room and boiler-house, one new water-tube boiler and feed pump, one 500 kw. mixed pressure Turbo-generator with surface condensing plant, new main switchboard, one new feeder and several mains extensions.

The most interesting feature of the extensions now in hand is the installation of the mixed-pressure turbine.

This turbine will be arranged to run either with the exhaust steam from the present reciprocating engines or with high-pressure steam from the boilers, or with a mixture of both. It is guaranteed to give 1 kilowatt hour with about 40 lbs. of exhaust steam or 21 lbs. of high-pressure steam. With a load of 100 kw. on the reciprocating engines it would then be possible to obtain an additional 70 kw. on the turbine without making any further call on the boilers.

A "Lea" water recorder will be installed in conjunction with the turbine in order to measure the steam consumption of the turbine itself or of any of the reciprocating engines exhausting into it.

It is interesting to note that, since the purchase of the undertaking, the number of customers has increased from 50 to 740, the maximum load on the mains from 70 kw. to 500 kw., and the number of units sold per annum from 100,000 to 750,000.

The total running cost per unit sold, for the last complete year's working was 0·76*d.*

The Borough Electrical Engineer is Mr. S. Cameron Gibson, A.M.I.E.E., to whom the Author is indebted for the above information.

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Water Supply.

Within the last ten years the average daily consumption of water has increased from 400,000 to 628,000 gallons. The main source of supply is at Whittleford, from two wells sunk 360 feet in the Permian, acquired by the Council in 1900 after they had been abandoned by a Colliery Company on account of an inrush of water. The pumping plant (which was fully described in Mr. Pickering's paper) comprises compound horizontal condensing engines with ram-and-plunger pumps, and delivers the water to the filter beds through 1620 yards of 12-in. pipes, against a total head (excluding friction) of 445 feet.

The pumps were originally fixed at the then water-level, which was 180 feet below the surface; but as the demand for water increased the pumps were gradually lowered in the well until they are at present at a depth of 315 feet below the surface. The yield from the wells is now 500,000 gallons per day, and is evidently nearing its maximum.

The Corporation own a second pumping station, at Robinson's End, which formed the original works of the East Warwickshire Waterworks Co., from whom the Council purchased the undertaking in 1897. There are two wells also sunk in the Permian, but farther from the outcrop 300 feet and 630 feet in depth respectively; the total yield is only about 80,000 gallons per day, and the station is merely used as a stand-by.

In addition, the Corporation purchase water in bulk from two extraneous sources—one a colliery shaft and the other a granite quarry. The total quantity thus obtained is about 26,000,000 gallons yearly, and the cost, pumped to the filters is 2½*d.* and 3*d.* per 1000 gallons respectively.

Pumping Cost.—The cost of pumping at Whittleford pumping-station, including maintenance of buildings, etc., is as follows:—

	£	s.	d.	Pence per 1000 gallons.
Labour	517	18	11	0·68
Fuel	271	18	5	0·36
Oils, waste, and packing	65	6	4	0·09
Repairs and renewals	77	2	5	0·10
Sundries	22	12	8	0·03
	£954	18	9	1·26

This works out at 0·28*d.* per 1000 gallons raised 100 feet.

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New Supply.—In seeking for an additional supply the action of the Corporation was limited by the knowledge that there are no unappropriated sources of supply within reasonable distance of Nuneaton, and that practically the only water-bearing rock worth considering within the borough is what is known locally as the 100-feet sandstone, in the coal-measures, whence is derived the bulk of the present supply. A site was acquired at Griff, to the extreme south of the borough, near to a shaft of the Griff Colliery Company, who proved water here in abundance at a sinking carried out in 1891. Mr. W. Whittaker, F.R.S., the eminent geologist, was called in by the Council, and reported in favour of the scheme.

Possession of the site was obtained in January of last year. A chimney shaft, 100 feet by 5 feet diameter was erected, two 30 feet by 8 feet by 120 lbs. Lancashire boilers fixed; the well, 14 feet in diameter, taken down a depth of 270 feet, and headings driven a total length of 36 yards. The average yield of the well is about 16,000 gallons per hour, and it is hoped that this will be augmented by extending the headings at a later date. The total estimated cost of the works is 15,000*l.*, including the provision and equipment of the pumping station and the laying of the necessary pumping main. The expenditure incurred up to the present amounts to 5800*l.*

Subsidence of Sites.—Waterworks construction in Nuneaton is rendered peculiarly interesting by reason of the fact that the pumping-stations, filter beds, and reservoirs are all situated on land subject to subsidence as the result of coal-mining.

At Whittleford Pumping Station the owners of the mines (Messrs. Stanley, Bros., Ltd.) have carefully packed one seam which has been already worked, with the consequence that, despite a surface subsidence of 4 feet, there has been very little damage done to the pumping plant.

The reservoirs have been subjected to exceptionally severe stresses, owing to the fact that the coal workings on the east side, which are about 400 yards deep from the surface, were stopped when within a few yards, horizontally, of the reservoir walls, with the result that the brickwork and concrete of the existing reservoirs were fractured in all directions. In 1906 it became necessary to construct an additional reservoir of 500,000 gallons capacity; in view of the circumstances, it was decided to utilise ferro-concrete (Hennebique system), and, as

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an additional precaution, the tank was surrounded with clay puddle, 18 inches in thickness. The cost was 3470*l.* It is satisfactory to note that the ferro-concrete reservoir is perfectly sound and watertight, notwithstanding that the fractures to the adjacent structure have given repeated trouble until quite recently.

The same conditions as to liability to subsidence applies to the filter beds, which are 200 yards distant from the reservoirs. In this case arrangements were made with the mine-owners to pack the workings likely to affect the site. The work of packing the one already worked seam is completed, and up to the present no damage has resulted at the surface. An additional filter bed, 450 square yards in area, was constructed in 1908, also in ferro-concrete. The filtering medium is mainly composed of Leighton Buzzard sand, and is 3 feet 3 inches in depth. The rate of filtration is about 500 gallons per square yard per day, and oxide of iron, which renders the water very turbid in appearance in its raw state, is quite successfully removed.

High-level Area.—In 1906 a high-level area was constituted for a portion of the borough which was formerly only intermittently supplied from the existing service reservoirs. A reservoir, 50,000 gallons capacity, was constructed in ferro-concrete on a mound formed of material excavated from a railway tunnel, the floor of the reservoir being fixed 12 feet above the level of the solid ground. The pipe connections were of flexible steel tubing, in order to guard against fracture due to settlement. The reservoir has remained quite sound and watertight. Filtered water is pumped to the reservoir by a 5 B.H.P. oil engine, and the mains are 4 inches and 5 inches in diameter, 2 miles in length. The whole of the borough is now assured of a constant supply of water at a pressure varying, according to level, from 35 lbs. to 90 lbs.

Daily Consumption.—The following figures (see Table on next page), relating to last year, show that the consumption of water is kept within reasonable limits. All meters are read monthly; house-to-house inspection is made at least twice yearly, and all taps found or reported to be leaking are re-washered free of charge.

New Mains.—Seventeen miles of new mains have been laid during the past ten years. In 1910 it became necessary to lay a duplicate 12-inch delivery main from the reservoirs to the

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Purpose for which used.	Consumption in gallons.	
	Total for year.	Per head per day.
Domestic	159,137,000	12·283
Trade	60,943,000	4·705
Municipal	9,197,000	0·701
	229,277,000	17·689

town. The greater part of the main was of spigot and socket cast-iron pipes; but a length of 1134 yards, subject to subsidence owing to mining operations, was of Mannesmann steel tubes, with a special "rigid" joint, caulked in the ordinary way with lead and yarn. The steel tubes cost 3*s.* 8*d.* per yard (laid complete) above the cast-iron pipes, and the Local Government Board only allowed a period of twenty years for the loan; but they have remained perfectly tight, whereas the joints of the old 10-in. cast-iron main, laid alongside, are still giving trouble.

Reduction in Charges.—It is of interest to record that during the last few years reductions have been made in charges amounting in the aggregate to 3637*l.* 18*s.* 8*d.*, which, in the case of a privately owned undertaking would presumably have gone in dividends to shareholders.

		£	*s.*	*d.*
1905.	Extra charge for more than one water-closet abolished ..	427	12	6
1907.	Reduction of 10 per cent. in water rates	2157	6	1
	Reduction of 10 per cent. in meter charges	784	16	1
1908.	Charges for baths reduced from 10*s.* to 5*s.*	268	4	0

The public further benefit by the fact that all water used for Municipal purposes is charged for at the flat rate of 3*d.* per 1000 gallons.

Sewage Pumping Station.

Old Plant.—The old plant, completed in 1898, comprised two horizontal compound condensing engines with cylinders 10 inches and 18 inches in diameter by 2 feet stroke, each working three-throw 15-inch bucket and plunger pumps. They were put down to raise together 130,000 gallons per hour from the bottom of the pump well to the delivery chamber at the pumping station, a height of 55 feet, but were subsequently

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utilised for pumping the sewage through 2½ miles of 16-inch main to the new outfall works at Hartshill.

New Plant.—The new plant will be capable of raising 100,000 gallons per hour to Hartshill, against a total head including friction, of 125 feet. The cylinders are 12 inches and 21 inches in diameter by 2 feet 6 inch stroke. The pumps are of the three-throw Ram type, 15 inches diameter by 3 feet stroke, and the spur wheels driving the pump shaft have "Citroen" cut gears. The steam consumption is guaranteed at 16 lbs. of dry steam per 1 H.P., or alternatively 21½ lbs. steam per P.H.P. at a boiler pressure of 120 lbs. per square inch. The makers are Messrs. Galloway, Limited, of Manchester, and the amount of their contract was 1748*l.*

Pump Well.—The enlargement of the existing pump well presented some difficulties. The well is 10 feet in diameter by 50 feet deep, and carried all the girders and other ironwork for the two sets of three-throw pumps, so that care had to be taken to cut away as little as possible of the supporting brickwork in order to avoid interfering with the stability of the structure. It was therefore decided to form a new pump chamber 15 feet 6 inches by 10 feet, taken down 23 feet below the engine-house floor, and to sink a well 10 feet in diameter, for the suction pipes, a further depth of 24 feet. The horizontal distance from centre to centre of the two wells is 16 feet; the brickwork of each is cut away for a height of 9 feet from the bottom so as to form a continuous sump, and the intervening space is utilised as an access shaft carried up to the floor level.

Extension of Engine House.—The engine house was extended a length of 30 feet 6 inches, so as to form a building 70 feet 6 inches by 29 feet. In connection with the extension it was necessary to raise the roof of the old engine house a height of 2 feet 6 inches. The roof was of timber purlins and rafters covered by slates, and supported on four steel principals, 29 feet span, and was jacked up in position from the walls on either side quite easily, and without breaking a slate.

The steam for the engines is generated by the refuse destructor plant.

Screening Chamber.—A new screening plant was provided in lieu of an old fixed screen in 1907. The screen is of Stott's make, and is 7 feet 6 inches in width by 6 feet 6 inches in height, fixed at an angle of 30 degrees, and is composed of 2½

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inches by ½ inch tapering steel bars placed ½ inch apart. At the rear of the screening chamber is a detritus pit fitted with bucket elevators. The raking apparatus for the screens, and the bucket elevators are actuated by a small horizontal steam engine, formerly used in connection with the abandoned sludge pressing plant.

The screening chamber is 18 feet in depth, so that the screen itself is necessarily submerged under certain conditions of flow.

Refuse Destructor.

The first refuse destructor was put down by Mr. Pickering in 1901. It comprised a Meldrum front-feed three-gate furnace, with a total grate area of 70 square feet, and capable of dealing with 30 tons of refuse per day of twenty-four hours. The destructor was coupled up to an existing 27 feet by 7 feet Lancashire boiler, working at a pressure of 80 lbs. per square inch. The chimney was 100 feet in height by 5 feet square at the top.

Test figures of refuse destructors usually relate to new plants working under ideal conditions for a few hours only. The following figures of a test made of the above-mentioned plant, in March of last year, may therefore be of interest.

It should be mentioned that the destructor was erected ten years ago, and had been in use for forty-two consecutive days prior to the test being carried out:—

Duration of test	37½ hours.
Time taken cleaning fires	6½ hours.
Refuse consumed	63,868 lbs.
„ „ per hour	2400 „
„ „ per sq. foot of grate per hour	24·33 „
Percentage of clinker	32·65 per cent.
Average steam pressure maintained	60 lbs. per square inch.
Temperature of feed water	94° F.
Water evaporated	90,000 lbs.
„ „ per hour	2400 „
„ „ per lb. of refuse (actual) ..	1·409 „
„ „ „ at and from 212° F.	1·627 „

The refuse destructor and a coal-fired boiler were utilised alternately in periods of six weeks, so that it was practicable to obtain accurate figures of the cost of destroying the refuse. The gross cost of labour is somewhat high, owing to the fact

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that the plant only deals at present with 18 tons of refuse daily, and worked out at 1*s.* 8·83*d.* per ton. The total nett cost (excluding capital charges), taking into consideration the saving in coal, was 4·9*d.* per ton. The fuel used in the coal-fired boiler was coal dust, which cost last year 2*s.* 10*d.* per ton in the fire hole.

A duplicate destructor, of similar type, has recently been constructed by Messrs. Heenan and Froude, of Manchester, so that the plant in future will work continuously. The three grates have a total area of 75 square feet, and will be capable of consuming 45 tons of refuse per twenty-four hours.

Two new Lancashire boilers, each 28 feet by 7 feet 6 inches by 120 lbs., have been installed in connection with the destructor furnaces, and one of the old boilers has been re-erected for firing with coal as a stand-by. Steam from the destructors is utilised for pumping sewage, steam disinfector, and pumping and heating water for open-air swimming baths. The flue to the chimney has been covered with cast-iron plates, to serve as a drying floor for tar-macadam.

Sewage Disposal Works.

Original Works.—The sewage disposal works at Hartshill were designed by Mr. Pickering to treat a dry-weather flow of 500,000 gallons per day, and were first brought into operation in March, 1902.

The original plant comprised the following:—

Meter-house with "Venturi" meter, fixed on the outlet of the 16-inch pumping-main.

Two of Smiths' revolving screens, each 5 ft. 6 in. in width, actuated by a water-wheel, which is worked by the flow of sewage.

Three "Dortmund" silt tanks, circular on plan, 24 feet in diameter, with walls taken down vertically 11 feet below water-level and finished as an inverted cone at an angle of 60 degrees. Capacity of each, 50,000 gallons.

Seven primary contact beds, each 1000 square yards in area and 4 feet in depth, filled with granite broken to 3-inch gauge.

Seven secondary contact beds each 1000 square yards in area and 4 feet in depth, but filled as follows:—Three with coke breeze, one with unscreened coke-dust, one with ½-inch engine ashes, one with ½-inch washed granite chippings, and one with ¾-inch unwashed granite chippings.

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Irrigation area of 29 acres, with underdrains 2 chains apart and 5 ft. 6 in. deep, and outfall channels to the river Anker.

Present Dry-weather Flow.—The town is sewered on the partially separate system, rain-water from roads and the front roofs of houses being taken into a storm-water system. The present daily dry-weather flow is about 900,000 gallons, of which about 25 per cent. is trade water consisting of waste liquor from wool works and dye-water from factories. The daily dry-weather flow of the river, just above the outfall channels is 1,600,000 gallons.

Deterioration in Capacity of Contact Beds.—Owing to the rapid growth of the town on the one hand, and the gradual deterioration in the capacity of the contact beds on the other, the desirability of further extensions of the works soon became apparent.

In connection with this loss of capacity, the following figures may be of interest. The measurements were all made by means of a 6-inch "Siemen's" meter fixed on the outlet main from each bed. The beds were first utilised in March 1902.

Year.	Primary.			Secondary.		
	Total fillings.	Average per day.	Percentage capacity.	Total fillings.	Average per day.	Percentage capacity.
1904	4641	1·86	77 96	4285	1·83	87·16
1905	4608	1·80	69·00	4233	1·62	72·17
1906	5218	2·04	69·19	5940	2·32	57·35
1907	4408	1·72	79·88	5984	2·34	45·96
1908	3849	1·51	77·77	6356	2·49	34·77
1909	4811	1·88	71·08	{Conversion of secondary beds into		
1910	5613	2·20	61·54	{percolating filters taken in hand.		

Commencing in 1906 the broken granite in the primary beds was roughly screened, the intention being to deal similarly with two of the seven beds in each year; but this was obviously an imperfect method of cleansing the media, and in 1910 a start was made with washing, in the manner to be described.

The material in three of the secondary beds (one containing engine ashes and two granite chippings) was thoroughly washed after five years' work; but it was impossible to deal in this way with the coke breeze and dust with which the four remaining beds were filled, and these materials, together with

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the engine ashes, were replaced by washed granite chippings at the time the beds were converted into percolating filters.

New Work.—A percolating filter 60 feet in diameter and 7 feet in depth, was constructed in 1904, in order to determine the advantges of this form of bacterial treatment as compared with contact beds. The satisfactory results obtained left no doubt as to the policy to be adopted in future extensions.

The new work carried out since the completion of the original scheme comprises the construction of an additional silt-tank, two circular percolating filters, the conversion of the seven secondary contact beds into percolating filters, humus-tanks, sludge filters, the duplication of the existing system of under-drains, and further under-drainage, bringing the area available for irrigation up to 42 acres. The expenditure on new work amounts to 11,000*l.*

Silt Tank.—The new silt tank is square on plan, 28 feet by 28 feet. The walls are vertical for a depth of 10½ feet below water-level, and are finished as an inverted pyramid, at an angle of 45 degrees; they are brought up to form a continuous sill, over which the sewage flows in a thin stream to the collecting channels. The capacity is 75,000 gallons, thus bringing the total capacity of the four silt tanks to 225,000 gallons.

The silt tanks can be worked either in series or parallel. The heavy silt is removed under a head of 3½ feet and conveyed through 450 yards of 9-inch pipes for treatment as described. Since questions are often asked as to the working of deep tanks, it is of interest to record that no difficulty whatever has been experienced in the removal of silt, and that the original tanks have only been emptied once since the date of their construction, and then mainly with the object of painting the ironwork.

By reason of the situation of the works, and with a view to preventing aerial nuisance, the Local Government Board required that the original silt tanks should be covered over. The Author is of opinion that there are circumstances under which the covering in of tanks and channels may aggravate rather than minimise the nuisance it is sought to abate. At any rate, the roof of one of the existing silt tanks has been removed, with good effect; and the new tank has not been covered in, although provision has been made for this to be done if considered desirable in the future.

The capacity of the silt tanks—one-fourth only of the dry-

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weather flow—is below the usual standard; but so far as the elimination of suspended matter is concerned, the form of tank adopted is a prime consideration. At Hartshill the interposition of a long length of pumping main is an additional factor; and the results fully achieve the objects aimed at, viz. the preparation of the sewage for final treatment in the percolating filters, without the risk of carrying septic action too far.

Contact Beds.—The seven primary contact beds are retained as originally constructed. In addition to the part they play in sewage treatment, these beds act as balancing tanks for the percolating filters.

Separating Tanks.—After leaving the contact beds the sewage passes through separating tanks, in order to further eliminate suspended matter prior to treatment in the percolating filters. These tanks are each 15 feet by 15 feet square on plan, with the walls carried down vertically for 7 feet below the water-level, and finished as an inverted pyramid, similar to the new silt tank. The tank is provided with a wrought-iron grid supporting 18 inches of stone broken to 1-inch to 2-inch gauge through which the sewage passes in an upward direction, and the mineral matter which would otherwise tend to choke the percolating filters, is effectually intercepted. The rate of flow adopted is 37,500 gallons per square yard of roughing filter per day. The silt is removed from the tank, under pressure, every second day, and the broken stone is roughly cleansed, in position, once weekly.

The Author has found these tanks an economical and efficient means of removing suspended matter, and attributes to their action, in a large measure, the maintained capacity of the percolating filters.

Percolating Filters.—There are two percolating filters, originally constructed as such, one, 60 feet diameter (1904), and the other 90 feet diameter (1906), each 7 feet in depth and fitted with rotary distributors. These filters receive sewage in intermittent doses direct from the silt tanks; they have been working practically constantly since their installation, and no expense (other than for painting) has been incurred in respect of maintenance of the distributors.

The remaining percolating filters, seven in number, were converted from the original secondary contact beds.

Five of the beds were built with straight parallel walls, and

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these were conveniently carried up to form supports for the outer track of travelling distributors. The area of each is 1000 square yards, and the dimensions vary, but are approximately 163½ feet by 55 feet. The depth of media is 5 feet 6 inches. Two machines are provided for each filter, fed from a cast-iron trough fixed along the centre, to which the sewage is admitted over a V notch.

The remaining two of these beds were built with curved walls, in order to follow the contour of the land. It was therefore resolved to adopt a distributor of the "mono-rail" type, made by Messrs. Jones and Attwood of Stourbridge. The weight of the distributor is almost wholly carried on the single rail, the outer end being slightly weighted in order to give a bearing to the inner end on the underside of the central feed trough. The radii of the rail vary from 706 feet at the centre to 13 feet at each end, and the distribution of sewage is evenly maintained, notwithstanding the varying radii of the track, by an ingenious arrangement of weir plates governing the flow to the revolving drum.

Unlike the circular filters, the filters fitted with travelling distributors deal with a sewage which has already received treatment in contact beds. The distributors are arranged so as to give a rate of distribution variable at will from 50 to 200 gallons per square yard; but in practice distribution is maintained at the rate of 150 gallons per square yard per day. The rate per day at which sewage is applied to a filter is not necessarily a criterion of the quantity with which the filter will deal throughout twelve months. It may therefore be interesting to state that the percolating filters at work at the end of 1911 (two of which were constructed in 1904 and 1906 respectively) dealt with sewage applied at the rate of 151 gallons per square yard per 24 hours, and that the average daily quantity treated throughout the year was 136 gallons per square yard, or a reduction in efficiency, allowing for occasional periods of rest (sometimes due to shortage of sewage) of only 9 per cent.

Trials have been made with granite chippings varying from 1½ inch to ¼ inch gauge as media, and the conclusion has been arrived at that, under the conditions appertaining at Hartshill, the most satisfactory results are obtained with filters (5 feet 6 inches in depth) filled as follows:—

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2 feet 6 inches ¼ inch gauge
2 feet ¾ „ „
6 inches 1¼ „ „
6 inches 2 inch to 3 inch gauge.

It is found that under these conditions, and worked at a rate of 150 gallons per square yard per day the filtrate keeps clean, and that there is no ponding on the surface.

Washing Plant.—The Author is strongly of opinion that whatever material is used as a filtrate, either for contact beds or percolating filters, it should be one capable of being cleansed by washing. The stone-washing plant at Hartshill was erected in 1908. It comprises a 30 feet by 18 inch trough washer and elevator, actuated by a 10 B.H.P. "Dudbridge" oil engine. It is capable of effectually washing broken granite up to a gauge of 1½ inches at a cost, including loading carts, haulage to washer and back to filters, labour and oils, of 13*d.* per cubic yard.

The broken granite in the primary contact beds is too large to be washed in the trough washer, and the operation is necessarily performed by hand. The stone is washed with crude sewage, in the open delivery channels running alongside the beds. When a sufficient area is available for the purpose, the sewage, after being used for washing the stone, is run direct to the land; otherwise, it is intercepted in a specially constructed catchpit and pumped back to the silt tanks for further treatment on the works. The average cost works out at 14*d.* per cubic yard, with an additional 3*d.* for pumping back to the silt tanks when this is necessary.

Humus Tanks.—Two humus tanks have recently been constructed, square on plan, 25 feet by 25 feet. The walls are vertical for 7 feet below water-level, and the construction is similar to that of No. 4 silt tank. The tanks were designed for a maximum upward flow of 12 feet per hour.

Fish are maintained in the collecting channel, and furnish a practical test of the condition of the effluent.

Sludge Treatment.—In the wet winter months the sludge is applied to the land; but when weather conditions are suitable it is dealt with in sludge filters.

Three of these (1904) are of brickwork, 40 feet square. A false floor is formed of perforated glazed tiles, the intermediate space filled in with rubble, and provided with under-drains

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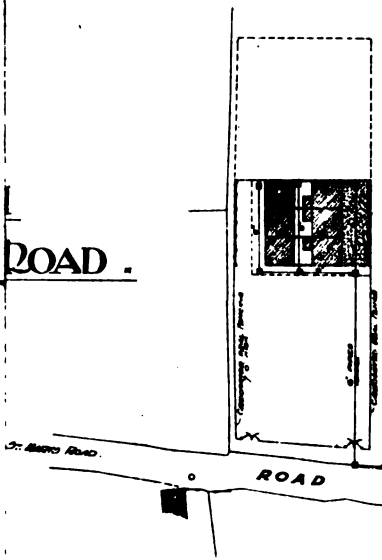
PLATE No 1

ROAD .



BLOCK PLAN

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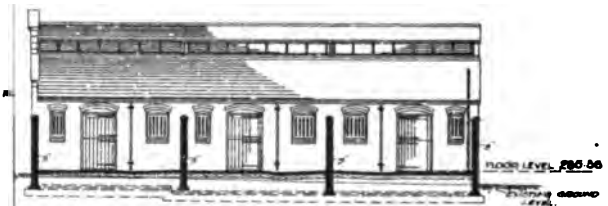

SECTION EF

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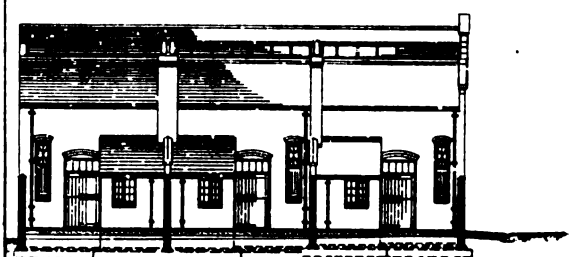

SECTION GH.

COOK, NUN

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EXPRESSED IN PARTS PER 100,000.

Description.	Free and saline ammonia.	Organic ammonia.	Chlorine.	Nitrogen in nitrates and nitrites.	Oxygen absorbed in 4 hours @ 80° F.	Total solid matter.	Suspended solids.
October, 1911.							
Crude sewage	4·08	0·704	24·5	0	9·69	170	54
Effluents from—							
Silt tanks	6·70	0·288	24·8	0	10·37	133	14
Primary contact beds	6·38	0·232	26·4	0	6·28	126	4
Circular percolating filters (direct from silt tanks)	0·040	0·125	28·4	3·96	1·17	138	Incubation satisfactory.
Rectangular percolating filters (after primary contact beds) ..	0·060	0·125	28·0	4·73	1·30	138	,,
Humus tanks	0·165	0·117	27·5	4·4	1·29	128	,,
March, 1912.							
Crude sewage	3·220	0·916	9·7	0	5·74	129	42
Effluents from—							
Silt tank	2·260	0·212	8·7	0	2·40	89	5
Primary contact beds	2·200	0·176	8·1	0	1·79	81	5
Separating tanks	2·130	0·128	8·4	0	1·75	80	
Circular percolating filters (direct from silt tanks)	0·013	0·221	8·9	1·98	1·52	82·5	0·5 } Incubation
Rectangular percolating filters (after primary contact beds) ..	0·018	0·119	10·6	2·53	1·01	93	1 } satisfactory
Humus tanks	0·276	0·103	12·4	2·31	0·810	85	trace }

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leading to the outlet chamber, and thence to a specially prepared area of land.

Three additional filters, each 400 square yards in area, have since been formed by merely excavating in the ground, with the sides battered to form the walls of the tanks. The bottoms are under-drained with 4-inch earthenware pipes packed with rubble, and covered with a few inches of ashes to receive the sludge. This type of sludge filter is obviously cheaper, and rather more effective, than one constructed of permanent materials.

In dry weather the liquid sludge is treated in the sludge filters. In about ten days the sludge is reduced to about one-third of its original bulk, when it is sufficiently dry to load into barrows for removal. A ready sale is obtained at 1*s.* per load.

Sewage Analyses.—The results of analyses made by the county analysts, Messrs. Bostock Hill and Rigby, are shown on preceding page.

DISCUSSION.

MR. E. G. MAWBEY: It is a most interesting and instructive Paper, and deals with works of the first importance, reflecting the greatest credit upon the Corporation, as well as its engineers who have prepared and carried out these schemes. I agree with the Author, that, notwithstanding the great advantage to road users of tar-spraying as a dust preventive, the expenditure of something like 55*l.* per mile per annum is very much the reverse of economical, and the money would be better expended on a more permanent method of treatment. We all know, however, that, with the funds at our command, this is not possible at present, excepting to a comparatively limited extent, compared with the wide-reaching temporary relief made possible by the tar-spraying method. Having regard to the recent trouble by fish poisoning, and also the occasional failures in tar macadam, it seems inevitable that we must refuse to use crude or unrefined tar, from which the well-known damaging constituents have not been removed. The success of the floods prevention scheme reflects great credit upon its Author. The flood on the last day of the last century referred to was also the greatest recorded flood in Leicester. The great flood scheme for Leicester,

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mostly prepared and carried out by the late Mr. Gordon and Mr. F. Griffith, and completed by myself, was designed on a basis of discharging volumes actually flowing off the drainage area equal to a rate of $1\frac{2}{3}$ (one and two-thirds) inch per twenty-four hours. This provision proved ample on the occasion of this great flood. The construction of the waterworks reservoir with ferro-concrete is interesting, and one would like to know what term of years was granted for the repayment of the loan. The capacity of the silt or sedimentation tanks at the sewage works is given as only one-fourth of the dry-weather flow. It is, of course, below the usual standard; but, as the result of extended experiments at Leicester in 1898–9, I decided that from one-fourth to one-fifth was the best proportion, to minimise septic action (a course which I have always strongly upheld), and the works carried out here on this basis have proved the advisability of this ratio. The grading of the various media used for the single-contact beds in Leicester varies from three-quarters of an inch to two and a half inches, and with the before-mentioned capacity of sedimentation tanks in use, the reduction of water capacity of these beds after five years' use amounts to thirty-one per cent. of the original water capacity, but the present water capacity is still well over thirty per cent. of the gross capacity, and there is no ponding. There is at present no necessity for any washing of the materials.

Mr. N. H. Dawson: I see Mr. Cook states the County Council grants the Corporation of Nuneaton the sum of 2100*l.* per annum for $10\frac{3}{4}$ miles of main roads. That works out at about 195*l.* per mile, the same amount as we have in Banbury. I would like to ask how many tons of stone per mile per annum is laid on the main roads. Either there is a great amount of metal and very heavy traffic, or else the County Council must be very liberal to Nuneaton. You have stone at 2*s.* 3*d.* per ton, and a similar stone costs us 9*s.* 3*d.* per ton. That shows what a great advantage this borough has in having its own quarry. With reference to tar-painting, Mr. Cook remarks that "an expenditure of something like 40*l.* a mile year after year, with the sole object of dust prevention, and without any prospect of effecting permanent improvement to the highway, appeared a particularly uneconomical way of dealing with the matter." I beg to differ from him. I think the diminishing of the dust nuisance in a town is of very vital importance; then there is a saving in

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the watering of the roads, and I believe, if continued for two or three years, there will be a saving in the cost of maintenance, as the tar helps to bind the stone together to a great extent, and will increase the life of the road. I think Mr. Cook is very happy in having constructed these separating tanks, especially as it is an economical way of removing suspended matter previous to treatment in the percolating filters. I thank him for the Table giving particulars of the material found to be satisfactory. It is a very valuable piece of information. I would like to ask how often has the media been washed since 1901 when put in, both the 3-inch and the smaller size media?

Mr. W. B. Chancellor: I should like first to propose a very hearty vote of thanks to Mr. Cook for the most interesting paper he has given us to-day. I do not agree with Mr. Dawson that 195*l.* a mile per annum is too much, taking into consideration the enormous amount of traffic we have on our main roads at the present time. I should be glad if Mr. Cook could tell us how that figure compares with the actual cost. My experience of entering into contracts with County Councils is that the county surveyor sees that the sum granted is expended, and as much more as the local authority are good enough to give. The Nuneaton Council are to be congratulated on obtaining road material at such a small cost. Could Mr. Cook give us the cost of repairing roads three or four inches thick, and also the cost with tar-macadam of the same thickness? I should also be glad to hear how tar-macadam has answered in Nuneaton, particularly where the traffic is considerable. With regard to tar-spraying, I notice crude tar has been used. I should be pleased to know whether any difficulty was experienced with the roads in the winter months, as I have found, when crude tar is used, a nasty, greasy crust is formed. With distilled tar no trouble arose. I see the cost per square yard of tar-spraying was practically the same as at Lichfield last year, excepting that we used distilled tar. I am glad to see Mr. Cook mentions the monetary considerations of the reconstruction of the highways. We are expending 40*l.* a year for preventing dust without permanently improving the highways. The general public are becoming every year more and more particular; what was a good road ten years ago would be utterly condemned to-day. The cost of materials and labour are increasing every year, but local authorities are very loth to proportionately increase their estimates.

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If the money expended in treating dust could be devoted for permanent improvements to the highways, the benefit would be more lasting, but, unfortunately, it cannot be thought of; motors have come to stay, and we are living in a very advanced stage of civilisation. The only silver lining to the dark clouds of the lot of a municipal engineer is the hope that aviation will ultimately supersede road traction. With regard to the small-pox hospital, I congratulate the Corporation upon not having had occasion to use it, but I question whether the buildings are improving in being left unoccupied for so long a period. I congratulate Mr. Cook upon the ferro-concrete reservoir turning out so satisfactorily. Respecting the sewage disposal works, there is no doubt the loss of capacity in contact beds is very serious. This does not apply to anything like the same extent in a percolating filter. We have percolating filters at Lichfield twelve years old which have lost very little of their working capacity. Some of the new percolating filters, I notice are 7 feet deep. This depth is, I think, excessive, and I should be glad to know if Mr. Cook could tell me whether he has carried out any tests at various depths of the filters. I tried some filters some time ago, and found the greatest amount of purification was between 1 foot and 2 feet and 4 feet and 5 feet respectively. Below 5 feet very little improvement was found to take place. I agree with Mr. Cook respecting the capacity of silt tanks. One-fourth of the dry-weather flow, is, in my opinion, preferable to twelve and sixteen hours' dry-weather flow. Providing suspended matter can be kept down to five parts per hundred thousand, I am certain the final results will be much better. I am quite sure we have been overtanking our sewage and that much of the colloidal trouble is brought about through the sewage being over septicised.

Mr. G. W. Lacey: I have pleasure in seconding the vote of thanks. I should like to congratulate the borough of Nuneaton on the statistics, on the height of the birth-rate, and the lowness of the death-rate. It speaks very well for the physical state of the inhabitants of Nuneaton that the birth-rate should be 31·2 per thousand, and that the death-rate, for a manufacturing town, should be so low as 11·8. I was rather surprised to find Mr. Cook was using crude tar for tay-spraying. I should hesitate to adopt that material, because of its varying quality. As to Mr. Chamberlain's complaint that a very dirty and difficult-to-

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remove crust is formed by the tar on the surface of the road in winter-time, I think that is produced by the meteorological conditions of the district in which the tar is used, and I have experienced the same thing myself. If a district is subject to a continuous amount of rainfall and the subsoil is moist, you do not get so good a result from tar as where the subsoil is dry and the roads dry very quickly. From my experience of tar as a preservative, I do not think there is a great deal in it. It does improve the conditions as to dust in summer time, but on roads with considerable traffic I do not believe it has much preservative effect; but on roads with lighter traffic, with two or three years' tarring, an improvement in the surface and a lengthening of the life of the road will be obtained. With regard to the small-pox hospital. The incidence of small-pox is very small, and the expenditure of 6000*l.* is a large one for a hospital for a single disease. One would have thought it would have been better to have provided a hospital for all infectious diseases, and put up temporary accommodation for small-pox in case of its being wanted. With regard to the water supply, I should be glad if Mr. Cook would state what system of inspection he has in the town, because the consumption of 17·9 gallons per head per day seems a very moderate one. There is one thing I cannot understand where the water undertaking belongs to the local authority, and that is why a special charge should be made for baths. I see it has been reduced by one-half. I should hope the Town Council will further reduce or remove that charge, because if the washing of hands and face is a legitimate use of water, the washing of the other parts of the body, which can only be properly done in a bath, is an equally legitimate and domestic use of water. With regard to the sewerage disposal works, it is interesting to know that the contact-beds have been replaced by percolating filters. As to the silt-tanks, I do not notice how frequently the silt is removed from those tanks. It is stated with regard to the separating tanks. It has surprised me that so a good a result has been obtained in the removal of suspended solids with so small a tank capacity. Mr. Chancellor says that if the solids can be reduced to five parts per thousand, it would be very good; it would indeed; if I get my suspended solids down to ten I think I am getting very good results. The construction of the separating tank appears a rather novel one, having the broken stone on the top. I would like

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to know if he finds with this coarse material there is any great effect in removing solids. With regard to the percolating filters, it appears that the flow is arranged very steadily upon those filters, because it states in the paper that the distribution is maintained at 151 gallons per square yard per day, which, with a depth of 5 feet 6 inches, means 82 gallons per cubic yard per day. I would like to ask whether in storm periods that is not increased very largely. I think, with the proper elimination of the suspended solids, you ought to get very good results from percolating filters, provided you are not working at a rate more than 80 gallons per cubic yards per day. But unfortunately our conditions have been such this year that we have had for three months running to deal with our maximum flow of 290 gallons per cubic yard per day, with the result that we get some trouble with slight ponding and the growth of colloidal matter on the surface. The filter effluent is, however, finally treated on land. With regard to the drying of the sludge, ten days for drying seems to be very rapid. I cannot get mine to dry in ten weeks. Mr. Cook must also be very fortunate in getting 1*s.* a load for it. With regard to the analysis, that appears to be very satisfactory. The percentage of purification in organic ammonia in the October analysis is 83, and oxygen absorbed 86·7, and, in the second analysis, from 88·7 and 85·9 respectively. There is a very great increase in the free ammonia after passing through the humus tank, and, with such a quick rate of flow through it, it is rather difficult to see why that should be. There seems to be very little difference between the effluent after passing through the humus tank and the filters on the first analysis, but on the second one, the effect of the passage through the humus tank is more marked. It is very difficult to form an opinion from one or two analyses, and if an average of a number of analyses in the year could be given, that would be very useful. Is the whole of the effluent treated on the land after passing through the filters or not?

Mr. T. R. Smith: A reference has been made to tar-spraying, and as far as my observation goes I certainly think it is valuable from the point of preserving the surface of the road. You get the tar sprayed over the whole of the surface, and for six months of the year the traffic is running over the tar and not the metal. As to whether there is much difference between crude and refined tar for the next six months I should hardly care to say. Whatever you

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tar your road with it is broken up and worn away in the winter months, though the haunches do not get as much worn as the crown of the road, and the tarring there may last till the next season. To this extent I do not think tar spraying is very valuable for preserving the surface. With reference to the question of crude or distilled tar, if the ordinary crude tar is thoroughly well boiled you get rid of a good deal of the light oils and water, and you get practically a prepared tar. There is some difficulty in doing this rapidly enough when tar-spraying, but in my own district I saw that our gas manager happened to be pulling out a boiler, and suggested that he should use it for boiling tar by putting some tubes in and running steam through. He has done this, so that we have practically a prepared tar waiting for us all ready and boiling when we send for it. We found it very useful last year, and we are doing the same this year.

I am interested in the paragraph about the separating tanks. Apparently there are one or two tanks, 15 feet square, in which the flow is upward through the material on the top. I am interested in that because at Kettering I put down straining filters, through which effluent passed after flowing through the septic tanks, so that if there were anything left in it might be removed before reaching the filters. We have two Dortmund tanks arranged for use as the final division of the septic tanks, and I have since found in practice that the effluent from these tanks is so clear we do not require the straining filters. The filters are rather larger than those in Nuneaton, and are filled with fine slag. They served us a very good turn during construction when the works were disorganised, but after the good work of the Dortmund tanks it is not necessary to use them ordinarily, though they are very useful for standby. Mr. Lacey drew attention to the rise in free ammonia in passing through the humus tanks. It raised a query in my own mind as to whether it is due to anything in the tanks themselves. We have a plentiful crop of flies and larvæ in our tanks, and if this takes place in the tanks here there might be some small rise of free ammonia. As regards sludge treatment, I have never worked sludge filters. We have had sludge beds on the land, but I have always been sceptical as to whether much filtration takes place in sludge filters. I should have thought the treatment on land would be preferable. We had pressing plant for pressing our sludge into cake, but have abandoned the presser, and now use

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the compressed air plant for delivering the sludge on to the land, following pretty much the system in use at Birmingham.

MR. H. E. STILGOE: I think it is pretty well understood that the use of tar must be looked upon in the first instance as a great preservative of the road surface, and not merely as a dust palliative. Whatever one may say, we shall not get beyond that point. I think that has been discovered all over the country. I find it in my own case where we treated last year just under 100 miles of macadam road at a cost of 0·56 of a penny per square yard. We obtained the very best results in effect and economy.

MR. R. BLANCHARD: With regard to hospitals, I understand that Nuneaton has experimented in the Milne treatment. I was wondering whether Mr. Cook could give any information or whether it has gone beyond the experimental stage. If successful, I should think it would do away with the necessity of a good deal of hospital accommodation in our towns.

MR. F. E. G. BRADSHAW: The cost of the flood prevention work is stated to be 4000*l*. Does that include any compensation paid to the owners when the work was done, or is it the actual cost of the work?

MR. W. PLANT: Mr. Cook says they have an arrangement with the railway company by which the Council maintain the surface of the roads over the bridges. I should like to know on what terms the Council undertake the work. We have considerable difficulty with the railway companies. Will Mr. Cook also tell us whether the railway companies pay anything for scavenging the approaches to the bridges? With regard to dust prevention, I should like to know whether he has used any of the various palliatives on his tar macadam with any ill effects. My experience is much the same as Mr. Stilgoe's, that tar-spraying materially increases the life of the road. It would be interesting to know whether the Council have been able to obtain any of the land for the street improvements referred to in the paper free of cost. At the Town Planning Conference last year one speaker stated that he got the owners in a nice frame of mind and often obtained the necessary land free of cost. I have not been so fortunate. I am afraid the land-owners are not very public-spirited in my district. As to the pumping at the Whittleford works, does that go on for the whole of the twenty-four hours? If only for twelve hours a day

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the velocity in the 12-inch rising main would appear to be excessive. The quantity of water obtained from the well at the new waterworks after sinking 270 feet seems to be very small. In my case we went down 47 feet and obtained a very much larger quantity. The statement that you get 1*s.* a load for the sewage sludge is very interesting; I think most of us have to give it away.

MR. NORMAN SCORGIE: As a metropolitan engineer there are one or two points to which I think attention should be called in this excellent paper. I certainly think you are not treated any too liberally by the County Council in the amount you receive for the main roads. I say that in the presence of our chairman, who is a county surveyor. I think I shall convince the meeting, and it may be advantageous to you in your next negotiations. You are particularly fortunate in the amount you pay for your road material, but what you save in the cost you waste in its use. I cannot conceive that the 42 miles of road in Nuneaton are capable of using 12,000 tons of granite per annum. Those 12,000 tons of stone, based on an average width of road of 24 feet, means that you are coating each one of your roads every 6½ years with 4 inches of granite, reduced to 3 inches consolidated. I do not think it would be the experience of Nuneaton that you would require such an immense amount of granite. Assuming that it is required, the cost of the material on 10¾ miles of main roads, apart from labour and carting, is between 1900*l.* and 2000*l.*—I give you that as an argument to the County Council that they ought to increase their contribution. As to tar-spraying, I agree with Mr. Stilgoe. We have to consider it not altogether as a palliative but as an adjunct to the preservation of the road surface. If corporations would only look at the maintenance of their roads in a permanent fashion rather than how much they can allow in the current year, it would be advantageous to them. They only look from the first of April one year to April 1 the next year. No engineer can show you a saving with tar-spraying or bituminous methods of construction on one year; we want three or four years. Then we are able to show that instead of a road wanting renewing every three years it only wants renewing every six years. I can quite understand that this town was laid out without any regard for street improvements. There is only one other point. We are told that the electricity

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works are remunerative, but the paper is silent about the cost of the street lighting of Nuneaton. The reason appears to me to be obvious when one turns to the pamphlet placed before us by the development committee. We are told that the gas works belong to a company, but that the electricity works belong to the Corporation. How interesting it would have been to have had some comparative figures of lighting the streets of Nuneaton by gas and electricity! Is the profit of the electricity works derived from the trade with private consumers or from the lamps it puts up for street lighting? As regards the flood prevention works, I think your engineer is to be congratulated, and I was pleased that the calculations he had made with respect to these works are borne out by that enormous work carried out in Leicester. Fortunately, as an assistant to the late Mr. Joseph Gordon and to Mr. Mawbey, I had the pleasure of being resident engineer. If the works are only the benefit to this borough that they are to Leicester, the money spent on them will be well repaid by the results obtained.

Mr. H. J. Coleby: I agree with the former speakers as to the application of crude tar in preference to distilled tar for street spraying. I have used crude tar for streets with light traffic, and it gives excellent results, comparing very well with the distilled tar used on the main roads. I find the distilled tar has caked on the surface of the roads, and is liable to break up in winter time in the case of frost, while the crude tar has penetrated deeper into the road. As the surveyor to the neighbouring district of Atherstone I take a lively interest in the doings of Nuneaton, and when I tell you that the Corporation have done us the doubtful honour of placing their sewage disposal works in our district, you will appreciate my interest and understand that I look after them. We all know that a certain amount of odour is inseparable from works of this character, and this under certain atmospheric conditions gives rise to a nuisance which in the case of these works has been the cause of a great many complaints to my Council.

I am bound to say, however, that since the conversion of the old contact beds to percolating filters the complaints have become fewer and fewer, and I hope the Corporation will continue their efforts and convert the whole of the contact beds into filters, when I feel sure there will be very little cause for complaint.

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I wish to support the vote of thanks to Mr. Cook for his very able and comprehensive paper.

THE VICE-PRESIDENT: Before calling upon Mr. Cook to reply to the discussion, I should very much like to say in a few words what my experience has been on this vexed question of tar. It has been entirely with reference to country roads, and I do suggest that any comparison made in the effect of tar should differentiate between streets and country roads, because it is the pace that kills, and open roads suffer far more from it than streets. I have found during the last seven or eight years that unless you do apply tar to the surface of these open country roads where fast motor traffic is heavy, you cannot keep your metal down. My experience has been that such roads when surface tarred annually, have at least 25 per cent. longer life, and this more than compensates for the cost of the tarring. One gentleman has referred to the fact that he has tar kept ready boiled for him at the gasworks. That is very useful when it can be done, but on a large area of country roads, where perhaps you have not a gasworks within twenty miles, I do not see how the tar can be kept boiling until it reaches the road. We make a practice of boiling the tar upon the spot, and putting it on the road immediately. The secret of success is to have the tar well boiled and brush it hard into the road fabric, leaving but a thin skin on the surface. This has the advantage on country roads of very little tar being left on the surface in winter time to bring horses down. If during the six dry months of the year you prevent the road fraying under motor traffic, you prevent considerable wear in material, and do very good work.

The vote of thanks having been accorded,

MR. F. C. COOK, in reply, said: From what has been said during the discussion it appears to be suggested that I have deprecated the continuance of tar-spraying. I have done nothing of the sort. We tar-sprayed last year eight miles of highways, and I am fully convinced that of remedies of that sort, which are not altogether permanent remedies, tar-spraying is the most effective, inasmuch as in addition to its utility as a dust preventive, it has the effect of lengthening the life of the road. In referring to an expenditure of 40*l.* a mile as a particularly uneconomical one, I am speaking of the use of those dust palliatives, the effect of which disappear at the end of the season without in any way

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tending to improve the surface of the highway. Then, with regard to the use of crude tar; I have tried distilled tar at an extra cost of 10*s.* per ton, and am bound to say I did not see that we had value for the money. The ferro-concrete reservoirs were constructed by virtue of an Act of Parliament, so we had not to make application to the Local Government Board. The annual cost of highways, main roads, and other roads, is 182*l.* per mile. We are always glad to get more money from the County Council, but I am bound to say we have not found them unduly sparing in that respect. If we make out a case, they treat us fairly. Mr. Chancellor is afraid the small-pox hospital buildings are not improving. There is a resident caretaker; the furniture is looked after, and at any rate the buildings are not going back. I agree with Mr. Lacey about the special charge for private baths. To my mind it is an anomaly that a local authority should charge a man for a bath at his own house, and at the same time incur an annual loss in respect of the upkeep of public baths. There has been no necessity up to the present to wash the media in the percolating filters, but I am convinced that the time will come, and provision has been made for the purpose. The effluent from the percolating filters is not treated on the land, but is taken direct to the river. The flow of 136 gallons per square yard per day is the average throughout the year. In reply to Mr. Bradshaw: We did not compensate landowners in respect of flood prevention works, but simply paid for land actually taken away. We had no difficulty in making arrangements with the railway companies for the maintenance to the surfaces of the roads and approaches to their bridges. The London and North-Western Company pay 46*l.* per annum in respect of 4 furlongs 7 yards, and the Midland Company 36*l.* per annum in respect of 1 furlong 167 yards. I do not suggest that we get land for street improvements free of cost; but where we desire to increase the width of existing highways the owners, generally speaking, treat us very fairly. Mr. Scorgie suggests that the fact of the Corporation owning their own quarry leads to an uneconomical use of stone. He must not think that the quantity raised annually is all used on the roads. Last year, for instance, the output was 11,272 tons. Of this quantity, 8035 tons were used on main and other roads, of which 5388 tons were from 1¾-inch to 2¼-inch gauge, and the rest chippings and dust. Of the balance,

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2500 tons were used at the sewage outfall works as filtering media. The Electric Committee do not make any undue profit out of public lighting. Their total revenue from street lighting is 576*l.* per annum, and there is no suggestion that that is not a perfectly fair figure for what we are getting. The pumping at Whittleford pumping station is continuous throughout the twenty-four hours. The cost of sinking the new well, and driving headings at Griff, apart from the erection of chimney stack and boilers, was 3800*l.*

The Mayor and Corporation entertained the Members to luncheon at the Newdegate Arms Hotel. The Mayor (Councillor T. Horton, J.P.) presided.

After luncheon, the Members proceeded in brakes to inspect the sewage pumping station, refuse destructor, open-air swimming bath, public slaughterhouses, and the sewage outfall works at Hartshill, with silt and humus tanks, contact beds, percolating filters, etc.

At the conclusion of the visit of inspection Mr. F. C. Cook entertained his confrères to tea at the farm buildings.

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SCOTTISH DISTRICT MEETING.

June 7, 1912.

Held in the Albert Hall, Stirling.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

PROVOST BAYNE and Sir Alan Seton Steuart offered a very cordial welcome to the Members on behalf of the Burgh of Stirling and the County Council of Stirlingshire.

The President thanked the Provost and Sir A. S. Steuart for the kindly and courteous welcome offered to the Members of the Institution.

Mr. R. Drummond, County Surveyor of Renfrew, was elected as the Scottish representative to the Conference on Road Material to be held by the Engineering Standards Committee.

STIRLING AND ITS MUNICIPAL WORKS.

BY A. H. GOUDIE, *Member*, BURGH ENGINEER, STIRLING.

HISTORICAL.

THE ancient and Royal burgh of Stirling is one of the most interesting towns in Scotland. Situated on the Highland border, it has held for centuries a most important place in Scottish history. The Romans had a station on the Castle Hill, this superseding the former defensive works of the Caledonian warriors. After the withdrawal of the Romans in A.D. 450, it is said that the Picts built a stronghold on the hill, and continued till driven out by Kenneth Macalpine in 843. From that time forward to 1746, the Castle was subject to many sieges and varying fortunes of war.

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The Burgh of Stirling is mentioned in a charter by King David I. in 1124, and in a number of other charters by the same monarch and King William the Lion, throughout the twelfth century. The earliest royal charter known to have been granted to the burgh of Stirling is that of King Alexander II., dated August 18, 1226, but it is well known that Stirling had a municipal existence for a long time before that date.

To tell the story of Stirling and its Castle would be practically to recount the history of Scotland. From the earliest times until the Union of the Crowns, the Palace was a favourite residence of the Sovereigns and the Court, while the Scots Parliament frequently met in the Parliament Hall. Some leading incidents only may be mentioned. The Battle of Stirling Bridge in 1297, and Bannockburn in 1314, secured for Scotland her independence.

Stirling was one of the burghs forming the Court of the Four Burghs, the records of which go back to 1295. In 1403 the Court met at Stirling and formed themselves into the Convention of Royal Burghs, still the most important municipal body in Scotland.

James II. was born at the Castle in 1430; the Earl of Douglas, murdered in the Castle by James II., 1452; James III. born there the same year; James IV. born in the same building, 1472; James V. crowned in 1513, when only a year old; Queen Mary brought from Linlithgow Palace and crowned in the Castle at ten months old; she spent her infancy in Stirling. Her son James VI. was in 1567 crowned in the Parish Church, which is still used for public worship. General Monk besieged and took Stirling Castle, 1651; in 1746, Prince Charlie entered the town and besieged the Castle, but failed to take it.

Places of Interest.

The places of interest in and around Stirling are very numerous. The Castle is of first importance. Placed on a commanding eminence, it dominates the landscape, and, before the days of improved artillery, was recognised as the key to the Highlands. It is of historical and antiquarian interest too great to be described here. The buildings have suffered much in times past from war, fanaticism, vandalism, and neglect.

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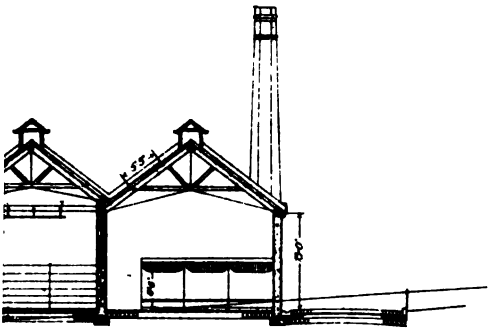

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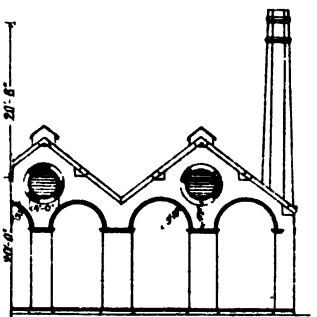

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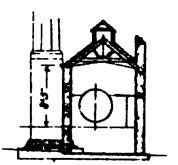

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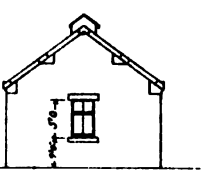

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They have now been put under the care of His Majesty's Office of Works, and they are being gradually brought into a state of better preservation. The most interesting buildings still standing are the Royal Palace, the Parliament House, the Old Mint, the Chapel Royal, and the Douglas Room, where James II. murdered the Earl of Douglas; the walls are still flanked with batteries both ancient and modern. From the walls a magnificent view may be had of the surrounding country, and the devious windings of the river can be traced for miles.

The Old Bridge of Stirling is a fine old structure of four arches, older than any of the existing Castle buildings, built in 1410. Partially destroyed in times of war and repaired in times of peace, it stands on or near the site of the ancient bridge, the scene of the fierce fight in 1297, when the English forces were cut to pieces by the patriot Wallace, a monument to whom is erected on the Abbey Craig, in a most commanding position overlooking the scene of his victory.

The High or Parish Church, although one building originally, is divided into the east and west churches. A church was founded here as early as 1124, and in 1414 it suffered severely from a fire, but was rebuilt, this second building forming the present west church. The east church was built early in the sixteenth century. The buildings are of great interest to students of Church architecture.

Cowane's Hospital or Guildhall is a quaint building standing close to the High Church, the home of the Stirling Merchant Guild, at one time an important body. Their benefactor, John Cowane, is represented in the stone figure above the doorway. Cowane's benefaction still exists, and, along with a similar foundation by Robert Spittal, tailor to King James IV., is managed by the Town Council. The revenues which are derived from feuing and agricultural land in and around the burgh, are devoted to charitable and educational purposes.

Argyll's Lodging, as it is now called, was built in 1632, by the Earl of Stirling. It is a beautiful specimen of the architecture of the period, and is now used as a military hospital.

There are a great many other old historical buildings of great interest still to be seen, but the Author is afraid that he has taken up too much space already.

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DESCRIPTIVE.

The town is beautifully situated. Built on the side of a rocky slope rising out of the fertile Carse of Stirling, it is almost surrounded by hills, having the Ochils on the north or north-east, with a row of pretty little villages extending along their base, commonly called the Hill-foots. The Grampian range to the westward forms a rugged line to the landscape in that direction, while the Touch Hills, from which the town derives its water supply, gives a soft tone to the varied beauties of the scene.

Toward the south or south-east the village of Bannockburn, which gives the name to the famous battlefield, is situated; then, looking to the east, the river Forth can be seen for miles winding its devious course to the sea. Having from an early date been a walled town, the houses within the line of the walls are crowded together. This is most marked towards the upper part of the town, and would probably be caused by the desire of the inhabitants to live near the Castle, which would be the centre of attraction when it was a Royal residence. The houses were originally very substantially built, although now many of them are in rather a dilapidated condition. Some of them were the town houses of the nobility and gentry, but when the Castle ceased to be a Royal residence the hangers-on of the Court also migrated, leaving their houses to become the homes of the successful merchants. But, as the town could only develop towards the lower parts, new houses sprung up in this district, and it became the new business centre of the town, the merchants also removing their homes to modern houses, which were erected in more healthy surroundings, and more conveniently situated to their business premises. The old houses in the upper part of the town thus gradually came down to be occupied by the poorest classes in the town, although a few of the older residents still retain their love for their old homes, and wherever that occurs, the buildings are still upheld in good condition.

The population is given at last census as 21,200, and the valuation amounts to 123,420*l.* 19*s.*

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Municipal Works.

Water Supply.—A good water supply plays a most important part in the success and development of any community, and from the foresight of our former rulers, Stirling has been well supplied with wholesome and pure water, at a rate which can compare favourably with any town in Scotland of its size.

The works are situated on the Touch Hill, the storage tanks and filters being about 4 miles to the south-west of the town, and the reservoirs, three in number, are placed one above the other, the largest and newest being fully a mile above the filters. The reservoirs are admirably situated, as the whole of the gathering ground presently in use, 1300 acres in extent, consists of wild rocky moorland which is quite unsuitable for cultivation. There is therefore no danger of contamination from the drainage of cultivated fields.

The water rights are held from the superior on reasonable terms; the reservoirs are feued at 1*l.* per acre, the ground at the filters at 4*l.* 16*s.* 9*d.* per acre, the other payments being percentages on the money collected by the Commissioners, the rate charged decreasing as the collected sums increase.

The largest and latest constructed reservoir, called No. 4, is 887 feet above ordnance datum; it covers an area of 31·805 acres, is 59 feet 4 inches deep, and has a holding capacity of 121,540,710 gallons. It has been constructed by forming an embankment at the low end of a sloping gully. It is supplied from three small streams, the main stream passing outside the lower end of the reservoir, but this water is taken in farther down the stream. The water from the waste weir also discharges into the main stream above the intake mentioned. The water is drawn off from the reservoir at three different levels through a wet well, circular in plan, built of concrete, and is carried down in a 2-feet fire-clay pipe to the compensation well, which is placed close to the main stream, a weir being built in the stream just below the well. The water in the stream is there impounded and taken into the well, thus combining with the water from No. 4 reservoir. The compensation water is given off through a rectangular orifice in the face of a concrete weir, said orifice measuring 30 cubic feet per minute, or 269,568 gallons per day. The remainder of the flow into the well passes over the concrete

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weir and flows into a stone culvert which forms the main supply into the next, or as it is called, No. 3 reservoir.

No 3 reservoir is basin shaped, covers an area of 15,173 acres, is 759 feet above ordnance datum, 30 feet deep, and contains 48,009,000 gallons. The embankment is a fairly long one for the size of the reservoir. The water is drawn off at two different levels through a circular wet well built of brick and discharges into the next, at No. 2 reservoir. There is a bye-pass pipe from No. 4 which discharges into No. 2, thus allowing the water from No. 4 to be used without passing through No. 3. A similar arrangement carries the water from No. 3 past No. 2. It is therefore possible to use the water from any one of the reservoirs separately, thus providing for the cleaning or repair of any of the reservoirs.

No. 2 reservoir is situated immediately below the bank of No. 3. It covers an area of 6·606 acres, and is 707 feet above ordnance datum, 20 feet deep, and contains 15,859,640 gallons. The embankment is a small one. This reservoir has a small intake at its upper end which helps to augment the supply, otherwise it is principally fed from Nos. 3 and 4 reservoirs. The water is drawn off at two different levels through a small circular wet well, and is carried down in a 16-inch iron main to the settling pond lower down. There is also a 16-inch from No. 3 discharging into the same pond.

The settling pond is a small reservoir 484 feet above ordnance datum and holding 3,213,000 gallons. Its principal duty is to act as a break pressure pond before the water reaches the filters; it has rough concrete walls, and the water is drawn off by three valves set at different levels. The supply pipes coming in to this pond discharge under water so as to cause as little disturbance as possible. A small burn also passes the side of the pond, and can be turned into it when the water in the stream is clear. When it has been disturbed by heavy rains it is sent down the bye-pass. Two 15-inch pipes from this pond supply the filters. There is also a bye-pass pipe, so that the water could be sent to the town without filtering, if necessary, but this has never been done since the filters were put in.

The filters are four in number; their level is 455 feet above ordnance datum; they are 76 feet by 52 feet by 6 feet 6 inches to 7 feet deep, built of concrete, the upper or exposed portion of the walls lined with white glazed brick. The water is drained

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off through centre and cross channels covered with pavement having open joints; the filtering material is regulated as follows: 1 foot 3 inches of 2½-inch whin metal, 9 inches of 1½-inch whin metal, 6 inches of ¾-inch gravel, and 2 feet of Arran sand. Two Glenfield sand washers are provided, and lately when washing the sand the finer material is taken off the top of each batch in the sand washers, and this is put on in a 3-inch layer on the top of the filters to prevent the discolouring matter from sinking down into the sand. One filter has been so treated, and it has proved a decided success. It has to be cleaned a little oftener, but a very thin skin requires to be taken off. When the filters have run a certain length of time it is easy to distinguish between the filter with fine sand and those without, a much thicker coat of deposit being found on the top of the filter with the fine sand than what is on the others, thus showing that a fair portion of the deposit is sinking down into the coarser-grained sand, and causing extra cost in washing.

The water from the filters is drawn off by four Glenfield decanter valves and the water taken in to two circular storage tanks 100 feet diameter and 16 feet deep, the two of them together holding about one day's supply. They are built with concrete, and lined with white enamelled brick.

The pipes from the storage tanks join together at a three-way piece which is connected to the three mains supplying the town, viz. an 8-inch, 12-inch, and 15-inch. Those pipes pass through the meter house separately, the 8-inch and 12-inch having the older type of Deacon meter, and the 15-inch being provided with the newer type of meter, having the Kelvin disintegrater, this being a great improvement on the older type, the dials registering the quantities and thus checking the reading of the diagrams.

The whole of the water district is supplied by the above three mains, the 8-inch is reserved for the Castle and upper part of the town and is an entirely separate supply. The 12-inch comes in about the centre of the town, and the 15-inch at the north end; they are then joined together. The pressure, especially at night, is very heavy, about 150 lbs. in the lower districts, but to obviate unnecessary waste the pressure is reduced wherever possible by putting in reducing valves. This is only done on side districts, as the direct mains have to be left under full pressure to enable the water to be sent to the out-

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lying districts, the pipes supplying those districts being to the small side. To further assist in the prevention or detection of waste, the town is divided into districts, each being supplied with a Deacon meter, so that whenever the meters at the works show an increase in the consumpt, diagrams are put on the town meters, and this enables the inspector to locate the district where the increase has taken place, and by shutting down the streets one after another he can tell in which street the waste is going on. This is found to be a great help not only in checking waste but in checking the work of the inspector.

The population supplied numbers 28,050, and the daily consumpt averages for the last year 1,489,483 gallons, giving a consumpt of 53·10 gallons per head over all, or a consumpt for domestic use of 38·59 gallons per head. This the Author considers not bad for a residential population like Stirling, but it should be very much less if the people would exercise ordinary care. As a proof of this statement the Author may say that owing to the long dry summer we had last year the supply was restricted, and the people were asked to assist by paying strict attention to see that no preventable waste should occur. So well had this request been attended to that when the reservoirs were filling up, and an unrestricted supply was turned on, the habits of carefulness engendered during the scarcity seemed to bear good fruit, as in the first few months the consumpt was only 33·51 per head for domestic use, showing how much of the waste is attributable to the carelessness of domestic consumers.

The average rainfall at the reservoirs during the last thirty years was 44·63 inches, the average for the three driest years being 34·77 inches, and the heaviest fall being 63·25 inches.

Sewers.—The diameter of the sewers ranges from 6 feet to 6 inches, and from the raised ground on which the greater portion of the town is built they have a good fall to the river, where they discharge mostly at or under low water. A few of the older sewers, where they run along the base of the rock, are rather deficient in fall, probably to avoid rock cutting, and have to receive regular attention. Thus the present generation is paying annually for the saving propensities of their predecessors. The ventilation of the sewers is by open grids through dirt boxes connected to the manholes, which are placed at or near the centres of the streets, and although perhaps not exactly an ideal system of ventilation, still appears to give very good

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results, as in no case have our sewers been found heavily charged with sewer gas, the workmen being able at all times to go into them without any ill effects. All house and other drains are trapped off before entering the sewers.

Streets.—The total length of streets and roads within the burgh is 21·018 miles, of which 2·829 miles are causewayed and 17·057 miles are macadamised. These comprise turnpike roads, statute labour roads, and roads taken over by the Town Council; there are also 1·132 miles of private roads not yet taken over. The principal streets are bottomed with concrete, and paved with granite or whin blocks grouted with pitch, the remainder and lighter trafficked streets being paved with whin rubble. The macadamised roads are of the usual type of water-bound road, but recently the Town Council have become alive to the fact that a better system of surfacing has become necessary, and they have sanctioned a limited length of roadway being treated with improved surfacing each year. The Council have also been successful in obtaining a grant from the Road Board for improved surfacing on the main north road, which runs through the centre of the burgh. The grant is only for tar-treated roads, the Board refusing to give any grant for rocmac, but as the Author was of opinion from actual experience that tar would not stand on a part of this roadway, which is between high banks and heavily shaded with trees, the Town Council have agreed to lay this portion with rocmac without any assistance from the grant, the metal to be used on the improved surfacing to be from selected quarries, the local metal not being of the hardest nature. The metal, blocks, kerbs, etc., presently in use are quarried in the Town Council quarry, where stones are dried and tarred in a tarring machine; but as Mr. Cox, the district road surveyor, is to give a detailed description of tarred and rocmac roads the Author need not go further into this matter.

Cleansing and Refuse Disposal.—The system of refuse removal within the burgh is by daily collection, the carts starting at 7 o'clock and finishing about 11.30. As the whole town is on the water-carriage system the refuse is of a light and comparatively inoffensive character, and might be even more so if the householders would recognise how much of it could be burned in their kitchen fires at a reduction in their coal bill. The refuse up to the present has been disposed of by tipping on

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land belonging to one of the Trusts under the Town Council, lowlying ground being raised to a higher level, and the whole surfaced over with from 18 inches to 2 feet of soil and then sown in grass. It has been found that ground treated in this manner gives a good crop of grass, but should there occur a dry summer in the first two or three years after the surface has been sown down, the grass is apt to be burned up owing to the heat from the partially decayed refuse underneath. There is also the danger to health from vermin, and the nuisance inseparable from such a tip from loose paper put out by the householders blowing over the adjoining fields. This latter nuisance might be altogether stopped if householders would burn their papers. The paper from all shops, warehouses, etc., is collected in bags by the cleansing department and sold to the paper mills, a small profit being derived from this source. The Town Council have had under consideration for some time the advisability of erecting a destructor, but the difficulty of finding a site where the steam could be properly utilised, and at the same time be free from objection by the surrounding householders, has so far been against it, they seemingly being under the impression that such a work would be a nuisance in the neighbourhood. This is a difficulty of course inseparable from such a town as Stirling, but will no doubt be got over as it has in other places, and the people will find that they have been needlessly alarmed.

Public Buildings.—The Public Hall was erected and is controlled by a company of local gentlemen. This is a very fine building, and acts as a town hall, being let for all public purposes. The Smith Institute, which houses the picture gallery and museum, was a gift to the town by Mr. Thomas Stuart Smith, a local gentleman, and is now under the care of a board of trustees. The Free Library was a gift to the town from Mr. Andrew Carnegie, and is a fine building which is greatly taken advantage of by the town's people.

The police buildings and court room are in an old part of the town near the Castle where at one time all the public life of Stirling congregated, and at that time the Town Council were located in the same buildings. With the changes of time the business population removed to the lower part of the town, the Town Council finding accommodation in the buildings in King Street, where they and the officials are very indifferently housed,

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the work of the burgh being very much hampered for want of sufficient space. The Town Council some years ago became alive to the difficulty of carrying on the work of the town in the present buildings, and they inaugurated a scheme for new municipal buildings, first putting past the equivalent grant to form a sum for this purpose. They then gave a premium for competitive designs, and although a very fine design was selected by the assessor, they unfortunately agreed to have a plebiscite, with the usual result, viz. a small vote and the decision cast against expenditure.

Public Parks.—Stirling is possessed of a fine park and other ground open to the public.

The King's Park, 156 acres in extent, is beautifully situated on the south-west of the town and from the higher parts a view can be obtained second to none in Scotland, or indeed anywhere else. This park is Crown land and is part of the ancient Royal Park of the Scottish kings. It is free to the public, and the Council exercise a general supervision over it; part is laid off for football in the winter and cricket in the summer. There is also a very fine nine-hole golf course, which is presently being converted into one of eighteen holes. The course is kept up by the Stirling Golf Club, but any one is allowed to play at a very small charge. The Gowan Hills are another very fine breathing space and recreation ground situated at the north-east end of the town amounting to 34 acres in extent. In addition there is a fine walk called the Back Walk, which is beautifully shaded with trees for about the half of its length. It then rises fairly high as it passes round behind the Castle, and is a favourite walk with the inhabitants.

Infectious Diseases Hospitals.—The general hospital was erected in the year 1904, at a cost of 14,000*l.*, and comprises two hospital blocks, an observation block, an administration block, and a disinfecting and laundry block. It is a fine building by a local architect, fitted with all modern appliances considered necessary in such an institution. The sewage is treated by the septic system before passing into the river. After the above hospital was finished the Board of Management were requested by the Local Government Board to erect a small-pox hospital, for which the Author was instructed to prepare plans. Those buildings were erected on a separate site about 2 miles from the town and are of a very unpretentious character, having a hospital

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block of two wards with four beds in each, an administration block with accommodation for three nurses, and an office block with laundry, washhouse, mortuary, etc. The building is erected with 11-inch brick, hollow walls harled on the outside; the whole cost, including laying out the grounds, a double iron fence round same, water supply, and a small septic arrangement for treating the sewage, only amounted to 1200*l*. The hospitals were erected and are now maintained by the Combination Board for the use of the burghs of Bridge of Allan, Dunblane, Callander, Doune, and Stirling. The county authorities are so satisfied with the position and arrangement of the small-pox hospital that they are presently negotiating with the Board for an extension of that hospital for the use of a certain portion of the county area about equal in population and valuation to the combined burghs.

Cemeteries.—The Stirling cemetery is situated on high ground just below the Castle. This is a very old burial-place, being the churchyard of the parish, and contains many interesting stones. This cemetery has had two additions at different times, which although now all in the same enclosure have different names, viz. Mar Place and the Valley cemeteries. The above cemeteries having become valuable owing to the number of persons even from outside the burgh desiring lairs, the Town Council were under the necessity of providing another cemetery to supply cheaper lairs for the poorer classes. They fixed on a piece of the Gowan Hills about the same level as the other cemeteries and to the north of the Castle. This place being wholly of a rocky formation was rather an expensive piece of work to start to; however, the Council purchased the ground from the Government, a plan was prepared by a local engineer, and the work was started by the town's workmen. The rock was used for road metal, and the work was only carried on as metal was required. This was found to be a very expensive method of carrying out the work, and when the Author came to Stirling it was one of the problems which he was expected to solve. Before long, on going into the matter the Author found that the expense of making the lairs was far above the sums at which they were being sold, but as the Council wished the cemetery for the poorer classes there was no use suggesting the raising of the price of the lairs, so after consideration, a new plan was produced with an estimated cost, of which the Council approved, and gave

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their sanction for the work being proceeded with at once. The actual cost came out below the estimate and the Council were enabled to sell cheap lairs without any financial loss, the price of the lairs in this cemetery ranging from 30*s.* to 6*l.*

Gas Works.—The gas works belong to a company incorporated under a private Act. The works have been in recent years almost wholly rebuilt and considerably extended. This has been done mostly out of revenue, and at the present time the company has a capital of 70,000*l.* They pay ten per cent. on the original shares, and five per cent. on the shares issued since 1898. Twenty candle-power gas is 2*s.* 6*d.* per 1000 cubic feet.

Electricity Stations.—In the year 1895 the Town Council procured a provisional order for supplying electricity within the burgh, and in the year 1899 the works were erected at a cost of 25,000*l.*, including plant, cables, etc. Since that date additional plant has been put in at a cost of 17,000*l.* The undertaking had its difficulties like many others, and for some years required to be assisted from the rates, but it is now in a more prosperous condition, able to pay its way and put a few hundreds to reserve fund. In addition to this the rate to consumers was reduced last year; formerly, current was sold on the maximum demand system, but it is now sold at a flat rate of 4*d.* per unit for lighting and 4*d.* to 1*d.* per unit for power, the output per annum being 397,924 units for all purposes.

Slaughterhouse.—Previous to the erection of the present building the old slaughterhouse was the property of the Common Good, the killing being done in private booths, the larger butchers being allotted one each, and the smaller butchers sharing the use of one or more booths between them. The ancient Incorporation of Butchers had certain privileges whereby their members only paid half dues, but when the new building was projected it was recognised that such privileges could not be continued, so an arrangement was come to whereby the Common Good paid the Incorporation a lump sum in lieu of all privileges, and the Incorporation agreed that their members would pay the same rate as the other butchers. After this difficulty was cleared up, the Author was instructed to prepare a plan of a slaughterhouse to be built on a different site belonging to one of the trusts under the Town Council, this plan to be on the open hall principle. The buildings, which were erected in

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1909, comprise three separate structures built of pressed facing brick with red stone dressings, the insides of the slaughtering and dressing premises being faced with white enamelled brick. The cattle- and sheep-pens are faced with brown enamelled brick. The building at the entrance contains the Superintendent's office and Inspector's room, with lavatory accommodation and store on the ground floor, with the Superintendent's house above. The main building contains the cattle-pens, slaughter-hall, cooking-room, diseased-meat chamber, pig-pens, pig-killing booth, and furnace-room. The cattle-pens are fitted up with white enamelled water-troughs and iron hay-racks above. The animals are all tied up, the stalls having open divisions formed of malleable tubes between every two, each set of stalls communicates with a passage which is separate from the stalls by a partition formed of malleable iron tubes, access being had through doors of the same construction. From this passage access is had to any of the killing-chambers through sliding-doors. The cattle-stalls and killing-chambers are so situated that the animals are roped in their stalls and led direct into the killing-chambers. The slaughter hall is divided into three chambers with open partitions formed of malleable iron tubing, so that the Superintendent can see all that is going on. Each chamber is fitted with two killing-places and two wall hoists. The carcases, when dressed, are lifted by the wall hoists and transferred to the trolleys on the runways; they are then run right through into the cooling-room without further handling. The trolleys, when first fitted up, were single, but it was found that, when loaded with a whole carcase, they did not run easily, and it was difficult to get them to pass the switches, so we traced two single trolleys together, and they ran so well that the Author believes the makers have adopted this improvement. Each of the killing-chambers is supplied with hot and cold water, the hot pipes being on the flow-and-return principle.

The cooling-chamber is placed at the end of the slaughter hall, and is cut off by a double door high enough to allow the carcases to be run through on the runways. There is also a weighing machine fitted up in this chamber, so that the carcases can be weighed while on the trolleys.

The diseased meat chamber is in this range of buildings, but is only entered from the outside. It is fitted up with a steam digester for destroying the diseased carcases. This is a very

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necessary, and, as it has proved, also a very valuable fitting, being almost constantly in use. When not destroying diseased meat, it is used for extracting tallow, which goes to help the revenue of the slaughterhouse. In this chamber is also placed a calorifier for supplying hot water to the various parts of the building.

The pig-pens are situated next to the pig-killing booth, the pens being enclosed with iron railings and supplied with feeding troughs. The pig-killing booth is fitted with a jib crane for lifting the carcases into the plotting tub; it then transfers them to the trolleys, which run to any part of the room for hanging up. There is also a trolley with pulley blocks for transferring to the hanging hooks and also for loading on to the butchers' carts. The furnace-room is the only other part of this block, and it is fitted with a small Cornish boiler for supplying steam for all purposes. The other block of buildings, including sheep-pens, killing-room, cooling-room, tripery, and hide-room.

The sheep-pens are fitted up with malleable iron railings, white enamelled water-troughs, and malleable iron hay-racks.

The sheep-killing room is placed next to the pens, and is fitted with the necessary dressing hooks, small pulley, blocks, etc. The cooling-room is next to the killing-room, the carcases being hung on flat bars fixed to malleable iron standards. The tripery is fitted up with white enamelled fireclay tubs, supplied with hot and cold water. There is also a steam-box for plotting feet, in addition a small portion is partitioned off for gut-cleaning purposes. The hide and tallow store is merely fitted with shelves divided to suit the different butchers. The whole cost of the buildings, including boundary walls, paved courts, water supply, drainage, etc., amounted to 6000*l.*

By-laws were drawn out by the Council and approved by the Local Government Board. A table of rates was fixed, which evidently was quite satisfactory to the butchers, as no grumbling has taken place, although they are roughly double what they used to be, the butchers evidently considering that the improved accommodation and better facilities for carrying out their work are well worth the extra charge. If all the butchers had loyally supported the scheme, the new place would have been self-supporting instead of having an annual loss of about 250*l.*, this loss being caused by three of the largest butchers killing

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in private slaughterhouses outside the burgh, which have been licensed by outside authorities.

A properly qualified Inspector of Meat has been appointed for the new slaughterhouse, and the amount of meat condemned during last year amounted to nine tons. This, without any legal proceedings, goes a long way to prove the need for a proper supervision of the public meat supply, and to show the necessity for some alteration in the laws which govern the erection and licensing of private slaughterhouses, and the inspection of all meat to be used for human food.

Hospital Trusts under the Town Council.—There are two hospitals and an Educational Trust under, or partly under, the Council, and they own a very large portion of the land available for feuing in and around Stirling. A good portion of this land has been or is being feued at present, the remainder being let as agricultural ground. We have no less than ten farms, three orchards, one nursery, and fifteen parks let for grazing. This of course entails a large amount of work on my department in carrying out repairs and improvements on the above properties. In addition to this there is the preparing of all feuing plans, and providing the plans for the feu titles. Although this does entail a lot of work which does not usually fall to the lot of a burgh surveyor, still, the Author thinks it is a position which many Councils would be happy to find themselves in, as it gives them great power over the class of buildings to be erected in any district. Recent legislation has proceeded on the lines of compelling owners of land to feu, and placing a tax on the increased value of the land, evidently proceeding on the assumption that there are large profits derived from feuing, and also that the ground would be more readily taken up if it were not for the heavy feu duties charged. This has not been the experience in Stirling. The highest priced land we have, and unfortunately we have only a small portion of this left, is in what we call the Terrace district. It is now feued at about 25*l.* per acre, but a very much less sum was got for most of the ground. This may seem a large sum, but when we consider the loss there is to the Superior for roadways and ornamental ground for which no feu duty is charged, also the loss of grazing value from the ground being broken up during the slow process of feuing, and the money that has to be expended in laying out roads, which is not recovered in many cases for

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a number of years, not to speak of the yearly upkeep of the ornamental grounds, it does not work out to be such a money-making business as one would be led to believe. We have other ground for small self-contained houses, or two-storey tenements of a good class let at 12*l.* per acre; this ground is fairly well taken advantage of. Again, we have ground in another district, which we let at 10*l.* per acre for workmen's dwellings. We have tried to favour the building of workmen's cottages, but so far these have not been taken up. Since we get from 4*l.* to 5*l.* per acre for grazing, it may be seen that, when you deduct the loss of area for roads and open spaces, and the cost of laying out roads, etc., then the profits cannot be so great after all.

The foregoing statement shows that the greater portion of the feuing ground in and around Stirling is owned by one or other of the Trusts under the Town Council. That being so, we are in the position to some extent at least of directing the lines on which our town shall develop, and have not the same clamant need, as many other burghs, for putting the Town Planning Act into force.

We have a very good example of what is called modern town planning in our Terrace district. In two of the roads there is the centre road for heavy traffic, and the two side roads for light traffic, with a grass bank between. Then there is the occasional small open-space, or ornamental plot, all the roads being planted with trees. This design has been carried out in a quite inexpensive manner and has rather a pleasing effect. The district is feued wholly for villas of a fairly good class. You can therefore conceive that the inhabitants will have some regard for the manner in which the grass plots and trees at the roadsides are kept, but in spite of that there are difficulties with message boys, who will form paths on the grass and also damage the trees.

So one can appreciate the extra difficulties that will have to be encountered when we have grass plots and trees in working class districts. The Author may say that the care of the trees and grass devolves on the hospitals, which own the superiority of the ground, at least that is what it comes to if you want the place to retain its good appearance.

In some of the recent proposals for town planning, money is to be saved by putting in back service roads of small width and

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light construction. Well, we have a somewhat similar arrangement in the district above quoted, only we call them Meuse Lanes, and our experience has been such that we stopped this arrangement in all our newer plans, as it has been found that the people use those lanes for depositing their garden refuse, and difficulties have been experienced in getting them kept even in a half respectable manner.

The description which the Author has tried to give of the municipal works of Stirling may, he trusts, be of some little interest to the Members of the Institution.

DISCUSSION.

MR. W. WEAVER: I beg to move a vote of thanks to the Author for submitting the paper to the meeting. The figures and description of the borough are most interesting.

MR. HOLMES: I have much pleasure in seconding the vote of thanks to Mr. Goudie for the very interesting and valuable paper he has given us to-day. There are one or two points I would like to refer to. The first is the matter of cleansing and refuse disposal. Some years ago I read a paper in Perth before the Scottish Association, which is now merged in this Institution, dealing with the subject of destructors. At that meeting I mentioned very specially a point Mr. Goudie has endeavoured to enlighten the public upon, and I am really surprised in these progressive days we cannot get people to do a little for themselves in the way of refuse disposal when it is known that by so doing it will be of advantage to themselves. Mr. Goudie says, "as the whole town is on the water-carriage system the refuse is of a light and comparatively inoffensive character, and might be even more so if the householders would recognise how much of it could be burned on their kitchen fires at a reduction on their coal bill." It is amazing to find the amount of garbage which is sent to destructors, also to tips in places where there are no destructors. Where there are no destructors the objection is greatest, because the tendency is to breed vermin and bring rats all over the place. In this very town a matter of fifteen years ago the site of these tips was a perfect nest for rats. In these days when we are waging war against rats and other vermin, it is of importance for residents to destroy this garbage in their fires, and not send it away to breed vermin. I hope Mr. Goudie

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and other surveyors will continue preaching that principle, and that in time we shall get people to listen to and act upon it. There is one other point, Mr. Goudie refers to the parks of Stirling. There are very few places which have been so fortunate as Stirling in the matter of parks. There is in this town one of the most beautiful parks to be found anywhere—the Kengo Park. At present land is very cheap in Stirling, and what I have often thought is that at Shiphaugh the corporation of Stirling might think of the advisability of acquiring a few acres of land on the side of the Forth. It would be a most desirable site for a park from where one of the most beautiful views in Stirling would be obtained by looking across the river to the Wallace Monument. It would also make a most desirable and safe playground for children, and I think the Council would be well advised if they considered the desirability of acquiring land for this purpose.

MR. J. LEE: Mr. Goudie says the depth of sand on the water filters is 1 foot 9 inches, and he seems to find a great advantage in putting 3 inches of fine material on the top of the sand. I think that is a very excellent plan indeed, but in the course of scraping, with only 3 inches of fine sand, will you not get down very quickly again to your rough sand. One might very well work the filters until there was less than 1 foot 9 inches on the top of the metal. In that way it means renewing your filter oftener than you would do otherwise. There is another matter with reference to the cleansing and disposal of refuse. The Town Council have evidently some difficulty in finding a site for a refuse destructor from the fear that it will be a nuisance to the neighbourhood. We have a destructor in the centre of the town in Paisley, and have had no complaint.

MR. G. BROWN: Do the council own their horses or hire them? I would like to know whether Mr. Goudie considers the best and cheapest method is to purchase or to hire horses for the cleansing department.

MR. P. C. SMITH: I should like to ask Mr. Goudie what is the cost of his road metal? Some of us have quarries three or four miles away from our burghs, and if Mr. Goudie would give us his figures, it would enable us to approximate the cost when the quarry is in the burgh. As to the disposal of house refuse, other councils are in the same position as to the advisability of erecting a refuse destructor. People will get the idea into their heads that a destructor is going to bring a nuisance. Over and over again we have

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been assured by representatives of firms who make destructors, and by surveyors who have destructors, that they can be worked without nuisance. As to the putting of garbage into ashbins my Council some time ago issued a representation to residents, asking them to assist by burning their paper and garbage in their own fire grates, and it has had a remarkable effect. If we could get the people to burn the garbage in their own homes, it would go far to solve the question of refuse destruction.

MR. FORBES: I should like to ask if there is any explanation of the apparent anomaly of the refusal of the Road Board to give Stirling a grant for rocmac while they gave Mr. Cox a grant for laying three miles of road with rocmac just outside Stirling.

MR. J. S. BRODIE: At some personal sacrifice I rose pretty early this morning to look round the burgh of Stirling, and I must say that a more beautifully situated town I have rarely seen. It is also well cared for, the streets kept clean and sweet, and I congratulate Mr. Goudie and the Council upon the very excellent way in which they look after their sanitary duties. With regard to the paved parts of the burgh, I notice that Mr. Goudie ventures to put setts upon gradients which I should hesitate to use setts upon. I should like to ask if there is any difficulty with the vehicular traffic in those sett-paved streets. I notice he has also some eighteen miles of macadamised streets, and I should like to ask whether he has used tar or bituminous asphalte in those streets, or whether he has done any tar spraying. We are very keen in the sister country on tar. But some of us are not altogether satisfied with our efforts, and would like to know whether it has shown any defects here. I have had charge of a refuse destructor for a good many years now. I must admit one can scarcely say that a destructor is "a thing of beauty and a joy"; it is at best an attempt at the solution of a very difficult problem—the successful conversion by burning of house and other refuse appertaining to a municipality at the least possible cost, and with the least possible nuisance to its neighbours. It is perfectly true there are destructors and destructors. Where you handle your refuse with the minimum of labour, and where you do not store your refuse preparatory to burning it, then I think you can conduct your destructor without being a nuisance to the immediate surroundings. But there are so many destructors where there is a huge pile of refuse

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dumped down preparatory to being cremated, and there comes in the nuisance. Very often the nuisance is felt from the uncremated stuff rather than from the fumes from the destructor itself. I will give the meeting a hint on this matter, and to be careful to on no account allow refuse to be dumped at the destructor works. Instead of spending money in storage bins for storing up refuse so as to burn it at a uniform rate, we have spent our money in providing about three times the number of collecting vans we would ordinarily use, so that after the refuse is put in the covered vans it is no more seen nor handled until it is dumped straight into the destructor itself. If you never allow the refuse to be exposed at all after it is collected until the time you have tipped it from the vans into the destructor, you have reduced the risk of nuisance from a destructor to the minimum. That method we have found successful. Our destructor is in the centre of the town, fairly near to the seafront, and in such a place you will see it would never do to have a nuisance so far as it could be avoided. Acting upon those principles during the past four years we have found, instead of complaints we are having people building houses close up to the destructor. The water supply appears to be very excellent indeed, and we in England always envy the Scottish towns on the quantity and quality of their water. Two years ago we were at Hawick, where they had actually a beautiful water supply running down the channels of the streets at full bore, washing the streets night and day. That is an ideal state of things that we sigh for and never attain. During the past four years at Blackpool I have had to extend our seawater works for watering and washing our streets, and for flushing the sewers, so you will understand we envy you the beautiful supplies of water you have in Scotland.

MR. J. YOUNG: In regard to the waterworks, I think this is a very good and novel method Mr. Goudie has of putting fine sand on the top of his filters. I would like to ask if he does this at all seasons of the year, or only during the time of the year when he has flocculent matter and peaty material coming down from his reservoirs that he finds it necessary to do so. In regard to the type of reducing valves, he may have found in a small area like Stirling it would be impossible to introduce the zone system of pressure in his waterworks. He has introduced the system of reducing valves on the side distributing pipes, and not on the main valves. I should like him to give us a description

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of the reducing valve, whether it is of a patent type, or an adaptation of his own, whether it is reliable in working, and whether he has any means of adjusting it so as to give the full pressure in the case of a fire breaking out. I have had experience of a refuse destructor being a nuisance, and also of one which is not a nuisance. In Ayr, we have a very up-to-date type of destructor. If it is properly worked no municipality need hesitate to go in for this method of destroying refuse. I do not think it is right to store refuse material. If that is done it shows there is something wrong in the design at the beginning. I would rather put in additional cells to destroy the refuse on the day it is collected. Provided the refuse destructor is put on the leeward side of the town, and the prevailing winds carry the smoke away from the town, and you keep the chimney 180 feet high, there will be no nuisance arising from the destructor. Very careful precaution will need to be taken as to the trapping of dust, because at times you will get dust from the chimney, unless you have traps and pockets for intercepting it, and insist on these being regularly cleaned out. As to smell, in the modern type of destructor there is no smell from the chimney as in the past. It is only this nuisance from dust that you may get deposited in the immediate neighbourhood on a calm day. I should like to ask Mr. Goudie when he considers a private road should be taken over, not only in respect to its condition, but whether it should only be taken over after the road and footpaths have been made up; or whether he takes over a road when only the carriageway is made, and the footpaths are made afterwards. Also his specification. What do the Corporation demand for the making up of a private street in such a way that it is taken over. I am also interested in the point raised by Mr. Forbes. It seems a hardship that Mr. Goudie did not get a grant for rocmac when the county was fortunate enough to get a grant. I would ask whether he did the work on the "Gladwell" method or the concrete method. Then I come to the slaughterhouses, and this is a part of the paper which is very full, and which shows that Mr. Goudie is to be congratulated on having an up-to-date slaughterhouse, a thing which cannot be boasted of in many towns of Scotland, especially our older towns, which have adhered to the ideas of former ages in the slaughtering of cattle. I am particularly interested in the digester for the disposal of diseased meat. If Mr. Goudie could

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give us the type of digester, and the maker's name, it might be of value.

MR. J. BRYCE: I would like to know from Mr. Goudie his cost for tarring metal per ton. I see that he has a machine here for doing it, and as I have also one I want to compare the cost. Then I was very much interested in the reference to the destructors. We think we in Partick are pretty far ahead in that respect, especially of the gentlemen from Edinburgh, who advised us not to have destructors in populous districts. I would have liked to hear Mr. Campbell on that point. It all depends upon the system, and the construction of the destructor. In Partick our destructor is in the very heart of the town. While in the beginning there was a sentimental complaint, we have not now a single complaint from any resident in the neighbourhood. In fact, our busiest street has been built up with new high-rated shops in the very vicinity of the destructor. I might mention a point in this matter which may be of interest. Our burgh electrical engineer has adopted a new cell—a cell which will lead to a revolution in the design of destructors, and mean a great saving in the cost of destructors. This is a travelling chain grate and the utilisation of water gas, and he hopes by the adoption of this method that instead of having to burn the refuse in six cells or, rather, four cells, because he keeps two aside, he can do it all in one cell. The refuse is not stored up, but is used for steam-raising purposes, and we get rid of it as soon as possible. We do not find it pays to have it lying about, and it is destroyed within a few hours of being delivered. Another point is the value of ground for workmen's dwellings. Mr. Goudie says, "Again, we have ground in another district, which we let at 10*l.* per acre for workmen's dwellings. We have tried to favour the building of workmen's cottages, but, so far, these have not been taken up." I am perfectly amazed at this. Of course, it shows the rooted affection of the people of Scotland to the old style of building, probably also a preference to live in the old historical streets of Stirling than to come out to a modern house or cheap cottage in the country. That prejudice has to be overcome by education; but there is no doubt the increased mortality due to overcrowding, and the insanitary conditions which must necessarily follow from these old buildings, point to the fact that it is high time that by some public-spirited person or the municipality, or, if necessary, by State support, something

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should be done on behalf of the people to provide them with cheap dwellings. I do not think there are many towns in Scotland or England who have this opportunity of land at 10*l.* per acre. Why, you can put twenty houses on an acre which would only mean 10*s.* for the ground for one house. It seems to me amazing that there is no public-spirited gentleman about Stirling who should take advantage of this, and advocate the removal of people from many congested houses in the streets of Stirling out to the more open country. Mr. Goudie says, "One can appreciate the extra difficulties that will have to be encountered when we have grass plots and trees in working-class districts." Mr. Goudie is referring to town planning here. I think it would be very foolish to try and lay out any grass plots on streets in working-class districts. I have always advocated, and I think it would be far better to arrange for a couple of acres—two or three acres—of open space for an area of about fifty acres. Better to have several small parks than to have a large park in isolated quarters of the town. No doubt a good many people have an objection to keeping a garden in order, but by the provision of a small open space of two or three acres here and there dotted all over the town I think you will get the best results in any laying out of a town-planning scheme.

THE PRESIDENT: To my mind there is no necessity for a refuse destructor to be a nuisance if it is of proper design and, above all, properly managed. I had in my town for many years a strong objection to the erection of a destructor, in fact for many years the townspeople would not hear of it. They continued what I considered the abominable practice of dumping the refuse in disused marl holes, not only the house refuse but a still greater abomination, the refuse from the old-fashioned middens which many towns in England still unfortunately possess. It must be and is a great nuisance and detrimental to health. Now, after a long time we persuaded the Council to have a refuse destructor, and we built the most up-to-date plant we could obtain, and I have never heard or received any complaint since this destructor has been erected. We do not allow the refuse to accumulate. We destroy it as fast as it comes on the ground, but I certainly think the suggestion of Mr. Brodie to have extra waggons is a very good one. In the very enjoyable visit which the Institution paid to Paris at Whitsuntide we found the Paris authorities had decided to take the whole of their house refuse eight or nine

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miles from the city. It is an expensive matter to cart your house refuse eight or nine miles out of the city, if you can destroy it within a reasonable distance, and there is no reason why a destructor should be a nuisance at all.

The vote of thanks to the Author was unanimously accorded.

MR. A. H. GOUDIE, in reply, said: I have to thank you for the very kindly manner in which you have dealt with my paper to-day. Mr. Holmes speaks about the burning of the refuse in the kitchen grate. There is something in that if the people would take advice. Our refuse is of a very light character and difficult to handle at the tip. As to Mr. Holmes' suggestion for the making of Shiphaughs grounds into a park, there is no prospect of such a thing at present, the proposal being to use part of it only for such a purpose. Mr. Lee speaks of the three inches of fine sand on the top of the filters and suggests a difficulty of handling it owing to the layer being so thin. My experience has been that by putting three inches of fine sand on the top of the filtering media the vegetation and other matter in suspension is deposited on the top of the fine sand in the form of a skin and does not sink into the sand at all. The reason I cannot put fine sand on all my filters is because the consumption goes up to such an extent in the winter owing to the people running the water at night, so that if there were this layer of fine sand on all the filters I could not get sufficient water through to the town. The saving effected is very great. You can clean one of these filters in half a day. Mr. Lee says there is no complaint of the destructor at Paisley. I think Edinburgh is the only town where there is such a complaint. The Edinburgh destructor has been a nuisance to all the people connected with it, and is now becoming the same to outsiders. Mr. Lumsden asked if we contracted our carting and what is the result. We believe it is cheaper, and we certainly have less trouble. We are not put to the disadvantage of having a Council who are all experts in horseflesh. Mr. Smith asked as to the cost of road metal. I debit the roads with cost of metal at 3*s.* 6*d.* per ton. The quarry gets some profit out of that price, which covers all charges, royalty as well. Mr. Forbes asked a question as to the road grant. The explanation of the Road Board was that rocmac is not dustless, and they were giving grants only for dustless roads. In my interview with them I said that tar macadam was not altogether dustless. They

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admitted that, but said there was less dust on tar macadam than rocmac, and could not see their way to give us a grant although they had given grants to other authorities. Mr. Brodie asked as to whether we had difficulties with setts on some of the gradients. We have had some difficulties in the higher parts of the town and have got over them by cutting out a space between the setts. Mr. Brodie also asked as to tarred roads. We are getting a grant of 500*l.* for improved surfacing; on the main North road we are laying a mile and a quarter of tarred road. The metal is being mixed through a small tarring machine—made locally. The tar I am using is composed of 80 per cent. of refined gas tar and 20 per cent. of natural bitumen. You will drive over that road to-day. Mr. Young asked about the reducing valve. It is a very simple type, which cannot be adjusted. You have to reduce either half or one-third. Mr. Young also asked what is done in the case of fire. There is a bypass to each valve, so that the water can be turned past at any time. Mr. Young asked as to private roads. In our case we only take over the carriage-way. We do not have any specification for roads here. Almost all the ground belongs to trusts under the Council, and the roads are made by our own workmen under my supervision. There is only one road belonging to an outside proprietor which has been made in my time, and it was taken over when made to my satisfaction. I gave the owner an estimate as to what it would cost to put it into a satisfactory condition, and the work was carried out by the town's workmen under my supervision. I am also asked as to whether the rocmac was put down on the concrete system. No, it was worked up from below. The digesting machine for diseased meat at the slaughter-house was made by Messrs. Marriott and Graham to my design, which is quite satisfactory. It was a new thing to them, and they have not made quite such a good job of it as I would like. Mr. Bryce speaks about grass plots and trees in working-class districts being foolish. I am of the same opinion, but it seems to be one of the innovations which we may look forward to. I am afraid the people will have to be better educated before they can appreciate and help to preserve such improvements. Mr. Bryce also suggests two or three acres of open space in every fifty acres. That seems a good idea for places for the children to play in, with a large park for adults.

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TREATED ROADS LAID DOWN IN THE CENTRAL DISTRICT, STIRLINGSHIRE, UNDER THE GRANT FROM THE DEVELOPMENT AND ROAD IMPROVEMENT FUNDS ACT, 1909, DURING THE YEAR ENDING MAY 15, 1912.

By D. R. COX, County Road Surveyor, Stirlingshire.

The Imperial Road Board made a grant to the County of Stirling of the sum of 4000*l.*, and of this, the sum allocated to the Central District amounted to 2000*l.*

The District Committee decided to first treat those portions of the roads which carried the greatest amount of traffic, and submitted a scheme to the Road Board which involved the expenditure of 2532*l.* in addition to the amount of the grant—making a total of 4532*l.*

The roads, lengths, areas, materials, and cost, were as tabulated hereunder—

Name of Road.	Materials.	Length.			Area Square Yards.	Sum per Superficial yard received from Road Board.	Amount of Grant received from Road Board.	Total estimated cost of work.
		Mls.	Fur.	Yds.			£ s. d.	£ s. d.
Bridge of Allan	Roemac	1	5	46	20,342	6*d.*	508 11 0	1059 9 7
Stirling—Edinburgh	Roemac	0	7	68	13,063	6*d.*	326 11 6	734 15 10
Stirling—Edinburgh	Tar Macadam	0	4	88	9,841	2½*d.* (Metal) 4½*d.* (Tar)	276 15 6	553 11 1
Stirling—Glasgow	Roemac	0	7	260	16,140	6*d.*	403 10 0	1040 5 0
Stirling—Glasgow	Tar Macadam	0	6	198	13,591	2½*d.* (Metal) 4½*d.* (Tar)	403 9 7	744 14 8
		5	0	0	72,977			
						Tarring plant	82 0 0	300 0 0
						Extra supervision		100 0 0
							£2000 17 7	£4532 16 2

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The Road Board approved of the scheme, and the work was commenced on May 25 of last year and carried on continuously until November 6, when the work was stopped until the spring, fully 4 miles having been completed. The remainder of the work was commenced upon April 15 of this year and the whole of the work was completed at the end of May last.

"Rocmac."

In laying this material the work was carried out in the following manner. The matrix in the proportion of $\frac{1}{3}$ cubic yard of crushed limestone to 5 gallons of "Rocmac" solution with an addition of a similar proportion of water, was placed upon a mixing board sufficiently large to admit of its being turned over three times in a similar manner to that of mixing concrete. It was then spread evenly upon the road to a depth varying from 1 inch to 2 inches according to the thickness of coat of metal to be afterwards applied.

The area covered by each portion or batch was from 8 to 10 superficial yards.

The metal was then spread over the matrix and rolled until the matrix came to the surface. All superfluous material was then swept off and the road left hard and clean. The traffic was kept off the treated road for a period of approximately twenty-four hours after completion.

After periods varying from two to twelve months, the portions of roads treated with "Rocmac" are in very fair condition with the exception of a small portion of the Edinburgh Road which has shown signs of giving way. Though the traffic upon this road is heavy, and includes motor-'bus traffic, the fact that only a small portion of the total length of treated road has given way suggests that the explanation is to be found in some local conditions, such as a defective foundation, rather than in the nature of the traffic which would affect the whole road equally. It is possible, however, that the extra rolling involved has accentuated this weakness.

The limestone used was procured from English, Irish, Welsh, and Scotch quarries. The greater quantity used was Welsh, but the others were found quite satisfactory.

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Tar Macadam.

The metal was mixed with tar at the quarry in the following manner, viz.:—

The metal was taken from the breaker and fed into the mixer without being heated in any way, the tar being fed into the mixer by a pipe from the tar boiler. The average quantity of tar used to each ton of metal was from 7 to 8 gallons.

The tar mixer was made by a local firm, and its cost 75*l*. The average quantity of metal coated with tar each day was from 50 to 60 tons. The tar used was purchased from three different firms, and was in conformity with the Imperial Road Board's specification.

Specification for Laying Tar Macadam.

As the surface of the portions of roads was inclined to be flat, a coat of clean metal from 2 inches to 3 inches deep was laid and rolled in the usual way prior to the tar macadam being put down. An average depth of 4 inches of tarred metal was then laid and thoroughly rolled. The Author considered that a coat of metal mixed with tar, 4 inches thick and thoroughly consolidated, would considerably strengthen the road and make it more impervious to moisture, and wear longer than a road treated by "grouting" or other such process. On one section of road a finishing coat of $\frac{1}{8}$-inch size of tarred Whinstone chips about $\frac{1}{2}$-inch deep was laid and rolled until a perfectly smooth and uniform surface was obtained.

On the other sections of road treated with tarred metal, no finishing coat of tarred chips was put on, the surface being simply tar-sprayed.

The Author is of the opinion that, although it gives an improved appearance and might with advantage be used in populous places, it is not advisable or necessary to surface tarred metal on a country road with fine tarred material. One reason for this is that, during frost, the surface thus treated is smoother, and it is consequently much more slippery, and must be regularly sanded to prevent accidents, which, on a long stretch of road, is not feasible.

One of the treated roads was laid with metal broken to a

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uniform size of 2 inches, whilst the remaining portions were laid with metal varying in size from 1½ inch to 2¼ inches.

The Author found that the best results were obtained where the metal was not of uniform size, a closer bond with smaller stones being the result.

The tar-macadam roads which have been laid down for about a year are in fair order, with the exception of that portion of the Edinburgh Road in the village of Bannockburn, where the surface of the tarred metal was coated with tarred chips. The surface coating of tarred chips gave way within a few months of the completion of the work. The result was that the whole of the surface required to be scraped off, leaving the roadway in a rather dirty state during the winter. The undercoat stood the winter well, and an excellent surface has now been obtained by tar-spraying.

General Remarks.

In view of the importance which the question of an "improved binder" for road surfacing has for all interested in roads at the present time, the Author feels it incumbent upon him to state his reasons for recommending his Committee to lay down the materials already described.

In this district a great number of the roads are laid upon a clay subsoil. Further, the drainage is far from perfect. The result is that, after a heavy fall of rain in summer—and it might be said for three or four months of the year during the winter—the roads are never dry. The Author's experience has been that under these conditions and with any considerable volume of traffic, tar in any form soon gives out. After careful consideration he came to the conclusion that "Rocmac," though not perhaps ideal in every way, was best suited to the prevailing local conditions.

After a year's experience of this material, the Author sees no reason to alter his views. In comparison with a bituminous binding, it is not, under certain conditions, so dustless, it makes a harder and less yielding road, it takes longer to lay, and is a little more expensive. Its advantages are: The dust is not so obnoxious as from tar, and after a few months, when the superfluous limestone has been washed off, the Rocmac dust is reduced. Further, Rocmac has propensities which admit of it

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suiting itself to climatic changes. It is less slippery in frosty weather, and during damp weather the traffic has not the same disintegrating effect as on a tarred road. Other advantages are that it can be laid at all seasons of the year except during hard frost, and that, when once laid, frost has not the same injurious effect upon Rocmac as upon other forms of road surface.

With regard to the actual cost of the work, both Rocmac and tar-macadam, while certain portions worked out a little more than the estimated cost, other portions were less, and the whole work was carried out within a few pounds of the original estimate.

In the south of England the life of such treated roads is assumed to be seven or eight years. In this district the Author has assumed an average life of five years. Certain portions will have a shorter life and others longer, and although still only an estimate, he sees no reason to alter his original estimate of an average life of five years.

Much might be said with regard to the economic aspect of such road improvements, but the paper is confined to the subject allotted to the Author, and is concluded by certain summaries of statistics of traffic taken in August and September, 1911, to enable members to compare the results of the work already done on the different roads. It will be observed from these tables that certain classes of traffic are greater on one road than on another, such, for example, as the large proportion of motor-'bus traffic on Edinburgh Road and the large proportion of ordinary motor and cycle traffic on the North Road, but a sufficient interval has not yet elapsed to admit of apportioning the tear and wear according to the class of traffic.

DISCUSSION.

MR. DRUMMOND: I rise with great pleasure to move a vote of thanks. I happen to have seen the work when it was being put down, and on several occasions since, and I must congratulate Mr. Cox on the way it was done and the way it is wearing. I am sure all the members will be satisfied, when they see the roads, as to the result of his efforts to improve the roads of Stirlingshire.

MR. R. H. DORMAN: I have very much pleasure in seconding the vote of thanks to Mr. Cox for his very useful paper.

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SUMMARY OF

STIRLING AND THE NORTH ROAD,

Between Stirling and Bridge of Allan.

Days on which Traffic was taken.

14th to 20th August, 1911.

Time each day, 6 a.m. to 10 p.m.

Width of Carriageway, from 18 to 26 feet.

Average width, 21 feet.

Classification of vehicles.	Assumed average weight.	Total in seven days.		Average Number.		Total weight in tons per yard width of carriageway.	
	Tons.	Number.	Weight in tons.	Per day.	Per hour.	Per day.	Per hour.
Ordinary cycles	0·09	7,050	634·5	1007·1	62·9	12·9	0·8
Motor cycles	0·18	290	37·7	41·4	2·6	0·7	0·05
Motor cars (including motor cabs and any other motor vehicles not specified)	1·6	1,222	1955·2	174·6	10·9	37·9	2·5
Motor vans (covered)	2·5	23	57·5	3·3	0·2	1·2	0·07
Motor omnibuses	6·0	55	330·0	7·8	0·5	6·7	0·4
Motor lorries (rubber tyres)	6·0	13	78·0	1·8	0·1	1·6	0·1
Trailers to rubber tyred lorries	5·0	1	5·0	0·1	0·01	0·1	0·01
Motor lorries (steel tyres)	10·0	1	10·0	0·1	0·01	0·2	0·01
Trailers to steel tyred lorries	5·0	—	—	—	—	—	—
Light tractors	5·0	—	—	—	—	—	—
Trailers to light tractors	5·0	—	—	—	—	—	—
Traction engines	12·0	13	156·0	1·8	0·1	3·2	0·2
Trailers to traction engines	8·0	28	224·0	4·0	0·2	4·5	0·3
Total motor vehicles and trailers ...	—	1,646	2853·4	234·9	14·62	56·1	3·64
Light vehicles (one horse)	0·4	1,806	522·4	186·5	11·6	10·6	0·6
Light vehicles (two or more horses) ...	0·6	34	20·4	4·8	0·3	0·4	0·02
Heavy vehicles (one horse)	1·25	594	742·5	84·9	5·3	15·1	0·9
Heavy vehicles (two or more horses) ...	2·5	114	285·0	16·3	1·0	5·8	0·3
Omnibuses (two or more horses) ...	3·0	—	—	—	—	—	—
Total horse-drawn vehicles ...	—	2,048	1570·3	292·4	18·2	32·0	1·82
Tramcars (Horse) †	—	521	—	—	—	—	—
Horses (led or ridden)	0·5	94	47·0	13·4	0·8	0·9	0·05
Cattle	3·0	1,021	806·3	145·8	9·1	6·2	0·4
Sheep and pigs	0·1	4,559	455·9	651·2	40·7	9·3	0·6
Hand carts and barrows	—	112	—	16·0	1·0	—	—
Horses drawing vehicles (to be calculated from number of vehicles) ...	0·5	2,196	1098·0	313·7	19·6	22·4	1·4
Grand total	—	19,247	6965·4	2674·5	166·92	139·8	8·71

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STATISTICS OF TRAFFIC.

STIRLING—GLASGOW ROAD,

BETWEEN STIRLING AND DENNY.

Days on which Traffic was taken.

4th to 10th September, 1911.

Time each day, 6 a.m. to 10 p.m.

Width of Carriageway, from 18 to 26 feet.

Average width, 21 feet.

Total in seven days.		Average number.		Total weight in tons per yard width of carriageway.	
Number.	Weight in tons.	Per day.	Per hour.	Per day.	Per hour.
3330	299·7	475·7	29·7	4·7	0·3
226	29·4	32·3	2·0	0·4	0·03
470	752·0	67·1	4·2	11·9	0·7
17	42·5	2·4	0·1	0·7	0·04
19	114·0	2·7	0·2	1·8	0·1
7	42·0	1·0	0·06	0·7	0·04
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
1	5·0	0·1	0·01	0·08	0·005
1	5·0	0·1	0·01	0·08	0·005
1	12·0	0·1	0·01	0·2	0·01
1	8·0	0·1	0·01	0·1	0·01
1743	1009·9	105·9	6·15	15·96	0·94
957	382·8	136·7	8·5	6·6	0·3
40	24·0	5·7	0·3	0·3	0·02
957	1196·2	136·7	8·5	18·9	1·1
20	50·0	2·8	0·17	0·79	0·04
—	—	—	—	—	—
1974	1653·0	281·9	17·47	26·59	1·46
—	—	—	—	—	—
24	12·0	3·4	0·2	0·19	0·01
74	22·0	10·5	0·66	0·35	0·02
239	23·9	34·14	2·13	0·37	0·02
186	—	26·5	1·66	—	—
2034	1017·0	145·28	9·08	16·14	1·0
8604	4037·7	1083·52	67·05	64·30	3·75

STIRLING—EDINBURGH ROAD,

VILLAGE OF BANNOCKBURN.

Days on which Traffic was taken.

21st to 27th August, 1911.

Time each day, 6 a.m. to 10 p.m.

Width of Carriageway, from 18 to 26 feet.

Average width, 21 feet.

Total in seven days.		Average number.		Total weight in tons per yard width of carriageway.	
Number.	Weight in tons.	Per day.	Per hour.	Per day.	Per hour.
3312	298·0	473·1	29·5	5·3	0·3
90	11·7	12·8	0·8	0·2	0·01
394	630·4	56·2	3·5	11·2	0·7
13	32·5	1·8	0·1	0·5	0·03
361	2166·0	51·5	3·2	38·6	2·4
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
—	—	—	—	—	—
6	72·0	0·8	0·05	1·2	0·8
15	120·0	2·1	0·01	2·1	0·1
879	3032·6	125·2	7·75	53·8	4·04
799	319·6	114·1	7·1	5·7	0·3
16	9·6	2·3	0·1	0·1	0·01
582	727·5	83·0	5·1	12·9	0·8
105	262·5	15·1	0·9	4·6	0·2
4	12·0	0·5	0·3	0·2	0·01
1506	1331·2	215·0	13·28	23·5	1·32
—	—	—	—	—	—
25	12·5	3·5	0·2	0·2	0·01
25	7·5	3·5	0·2	0·1	0·01
909	90·9	129·8	8·1	1·6	0·1
18	—	2·5	0·1	—	—
1623	811·5	231·8	14·4	14·4	0·9
8297	5584·2	1184·4	73·40	98·9	6·68

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The one thing that struck me in the two papers was that the Road Board refused contribution towards rocmac for the town of Stirling whereas they contributed towards it on the main roads in Stirlingshire. We have already had an answer to that question. On looking at Mr. Cox's paper and the figures given in it he gives 1*s.* 3*d.* per square yard, or rather less, as the cost of rocmac. That seems a very small figure indeed. In making an estimate myself of the price of rocmac, if used as a binder, I estimated that it would cost 10*d.* per yard super. I do not know, therefore, how Mr. Cox has been able to surface his road at 1*s.* 3*d.* I presume the stone in this district can be got very cheaply. With regard to the tarring plant, I see the Road Board contributed 82*l.* towards that. I take it that the plant, which cost 300*l.*, will be permanent, and although the Road Board only contributed 82*l.* that it will be used for many years in the county. I would like Mr. Cox to give us the exact figures for rocmac and tar macadam. In my county of Armagh I find the extra cost of treating stone with tar comes to about 3*s.* per ton, and I have calculated that rocmac would cost something like 7*s.* per ton. At the same time I am very anxious to lay down rocmac. As far as I can learn it is an excellent material to form a binder for rural roads. Another thing I should like to know is whether, when you spread a coat of rocmac 4 inches thick, what it will roll down to, whether it will roll down much or whether it will only consolidate to a small extent, or to the same extent as tarmac or loose metal would do. As to the specification for tarmac, I see Mr. Cox objects to putting a fine coat of tar on the top surface. I agree with him, although many members may not. When you put down this fine metal, and spread a thin veneer of tar on the surface, as they do in Kent, I do not think it is suitable in a district where you have young horses and cattle on the roads; half the cattle would be going on their knees to the fair. In laying down tar macadam and fluxing it afterwards there are a great many interstices left which you have to fill up with tar or small stone; but I should not like to have a veneer on the top, I like to see every stone showing on the surface. I came here to-day to see how you were dealing with your roads in this repect.

MR. R. S. ANDERSON: I would have liked to have seen a table of prices per square yard for rocmac and tar macadam.

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As far as I can calculate, the tar macadam comes out at 1*s.* 0½*d.* per square yard, which seems a very small price. It is clear that Mr. Cox must obtain his metal at a very low price per ton. I laid down a stretch of rocmac a year ago. It cost me 1*s.* 1*d.* per square yard, but that was with metal at 2*s.* 6*d.* per ton. So that Mr. Cox's figure is ½*d.* per square yard less than I was able to do it. The Road Board are up against giving a grant for rocmac. I think if surveyors find it the best method of road-making they should insist upon a grant for it. I may mention the Road Board were through my district the other day. They said if I could show such a good surface with tar-spraying we did not need tarmac or rocmac, but if the road is going to last three or four times as long it is a saving. The rocmac I have is in a better condition now than the day it was laid down. I was not in the happy position of Mr. Cox of diverting the traffic while the road was being made. I laid tar macadam at 11*d.* per yard without any tar-spraying over it, with the result that there was no slipperiness to be found in the winter months. If you put a spraying of tar on the surface of the road I do not see how you are going to manage in times of frost. There is a note in the paper that rocmac did give way under certain conditions. Perhaps Mr. Cox will mention whether there were any unusual conditions on that part of the road.

Mr. J. Andrew: About three years ago I put down an experimental stretch of rocmac, and I am glad to say that it is as good, or perhaps better, to-day than when it was put down. It was put down on what Mr. Young called the "Gladwell" system, and considerable rolling was required to bring the binder to the top. The next stretch put down was a section of road with a soft substratum, and in order to reduce rolling the binder, after being prepared, was mixed with 2½ times its bulk of metal, then spread on the old surface and rolled. This has been called the "concrete" system. The result was very satisfactory, so much so that all the work done since has been done on the "Concrete" system. The "Concrete" system is superior to the "Gladwell" system in respect that there is less punishing of the metal, the work is done quicker, and it can be applied to any thickness of coat. I had occasion once to raise the level of a street 9 inches, and there was no difficulty in rolling that depth of metal with the binder through it. I imagine it would have been almost impossible to have applied the "Gladwell"

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system in this case. Rocmac is not absolutely dustless, and I do not think any road is dustless, but it is mudless. In Helensburgh there have been a number of causeway crossings put down from time to time. These crossings are not necessary now, as the rocmac produces a surface equally clean. Uniformity in the surface of a road is to be desired, and consequently, when resurfacing, the crossings referred to have either been buried or removed, according to the levels determined, to the very great improvement of the street. Where possible the street is closed during operations; but there does not seem to be any difference in the ultimate result between the work done with the street closed and that done while traffic was going through. One of the first essentials of a road binder is that it should be possible to apply it in all kinds of weather. Rocmac possesses this feature in a special degree. I have put it down in all kinds of weather, and have had consistently satisfactory results. The cost over ordinary water-bound road has been 7*d.* to 10*d.* per square yard.

MR. FORBES: It would be of interest if those who are collecting statistics would, when making comparative statements of the value of surfacing materials, say something as to the nature of the traffic. Some of these roads referred to in this discussion may not require renewing in ordinary circumstances for from ten to fifteen years. I notice, however, that Mr. Cox's traffic is nearly nine tons per yard width; but with some of the roads Mr. Anderson and Mr. Andrews have referred to it is very much less than that. I should like to know if members can give the amount of traffic the roads they refer to are carrying. This paper also shows the proportion of self-propelled traffic. There is forty to fifty per cent. of self-propelled traffic, which shows the necessity of having some stronger wearing material on the roads.

MR. DAVID RONALD: I think Mr. Forbes, in speaking of traffic, has raised a very important point. In addition to the census of road traffic, there is another all-important factor to be taken into account, that is the weather, or rather, the climate of the district, in which improved roads are proposed to be laid down. In my opinion, it is not always the volume of traffic on the road that determines the mode of construction or the class of materials to be used; you must also take into consideration, so far as applicable to the district, the temperature, the rainfall,

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the winds, the relative humidity, the subsoil, and all the other factors which have a bearing on the life of the road. One can never say that the same class of road will be suitable for the south of England as for the north of Scotland—these being the extremes of maximum temperature in the British Isles—or for the east of Scotland, with a rainfall of 25 inches, and a high relative humidity, and the west of Scotland with 100 inches of rainfall, and a low humidity. The same applies to a seaboard town and an inland town with respect to the continuation of extremes of frost. Instances might be multiplied indefinitely; those cited above are sufficient to illustrate my point. Weather and climate must be carefully observed, the results tabulated, and these considered along with the traffic returns; and if this is done, and done systematically, a very great advance will be made on the present system of improved road making. I take this opportunity of thanking the two Authors for the valuable papers.

Mr. M. B. McBeth: I should like also to thank Mr. Cox for his paper, and to say I am glad Mr. Ronald has raised the question of weather, as I come from the west, where we have from 70 to 80 inches of rain per annum. When our rocmac work was being carried out the greatest rainfall was 1·23 inches, and the lowest rainfall 0·02 in twenty-four hours, while on several days it was absolutely dry, in fact, scorching hot. The rainfall had not the slightest effect on the work, and I defy any man to tell the difference between that laid on the wet days and that laid on the dry. The roadway laid was through Chalmers Street, Ardrishaig, to the pier, where all the heavy traffic goes, including a heavy motor 'bus in the tourist season, and to-day, more than a year after the work has been done, there is not the slightest sign of wear and tear on the road. The cost is a few pence more than a water-bound road. We pay 5*s.* 2*d.* to 5*s.* 6*d.* per ton for our metal, and with limestone at 9*s.* 2*d.*, and solution at 9*d.* per gallon, the cost has worked out, including scarifying and patching the old road, at 1*s.* 6*d.* per yard. The whole of the old surface was in a very bad condition, and a cost of 1*s.* 6*d.* per yard I consider extremely reasonable in the circumstances. This road is now the best in the district. In a district like mine, with so heavy a rainfall, it would not be possible for us to use tar with satisfaction. The district committee are considering the use of rocmac for the strengthening of the other

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important roads and streets. With regard to the question which has been raised as to the refusal of the Road Board to give a grant, my district made a claim last year, but, so far, there has been no result. Since then, representations have again been made, and we are hoping that next year we shall be more fortunate.

MR. A. STEVENSON: I thank Mr. Cox for the very interesting paper he has submitted with reference to this experiment, and the Road Board grant in the neighbourhood of Stirling. I would point out with reference to these experiments that, so far as Scotland is concerned—in fact, I think we may take it that in the whole of Britain—they are in the purely experimental stage; and I took the liberty of having a discussion with Mr. Walker Smith at the Local Government Board Offices, and also communicated with the Road Board as to the idea of having a considerable number of experimental stretches of road carried out by the Road Board on thoroughly scientific lines, so that the information obtained might be of value to the County Councils in Scotland, as to what was the proper material to work with in each locality. Sir George Gibb, in discussing the question, did not think it was necessary in Scotland to have more than two experimental stretches, one in the east and one in the west. I think that in the north there ought to be an experimental stretch in Elgin Street, Nairn, where we have one of the mildest of climates; in Argyleshire, where we have one of the wettest; and also in Lanarkshire or Dumfriesshire. You have different conditions in every one of those counties. I think if the Road Board were to make these experiments in all parts of the country in that way we will arrive at some proper data to work upon. But it is no use going on as we are now, of having 100 yards here and another 100 yards somewhere else. I have had some small experiments carried out, and my experience of rocmac is that it is an excellent material as a binder. My experiments worked out at 9*d.* and a fraction per yard. That depends entirely upon the locality. I think if an expression of opinion were made by this meeting, it would strengthen the possibility of getting experiments made all over Scotland.

MR. J. ROBB: A good deal has been said in favour of rocmac. In Mid-Lothian over two years ago a considerable stretch of the main road between Glasgow and Edinburgh was laid with rocmac, and I am able to agree as to the conduct of the material as a binder. The climate there is fairly dry, and adjoining

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sections of the road were laid with macadam, one surface tarred and the other pitch grouted; so that the three materials were in one continuous length. This is a road with a much heavier traffic than Mr. Cox's roads. In the first year it required no treatment, and during the winter there was very little mud. It was one of the best roads I have ever made as to surface and contour. In the following summer objections were made as to its not being dustless, and a petition was got up by the shopkeepers to have the road tar-sprayed. I pleaded with them to give it another year's trial, and although it is still in good condition, they insisted on its being tar-sprayed, and that has been done this year. Rocmac has thoroughly justified its adoption as a binder, but with heavy traffic it is far from being dustless. I can agree with what Mr. Anderson said of his Peebles roads. I was there two days ago with the Road Board, and a finer section of road I have never seen. But the weather was wet, and the road shaded with trees. Under those conditions I do not know a better road material. I saw it at several places in England two years ago, when the weather was also wet, and then formed the same opinion. While at Glasgow last year in dry weather it was far from being dustless. No doubt this material can be regarded as the best for a damp climate, but it will not do on the east coast. Mr. Cox seems to be against pitch grouting, but on the main roads leading from Edinburgh, I have fixed my mind on pitch grouting as the best road material for all kinds of traffic, and the County Council so far have backed me up. I do not know yet whether two years' extra life will be got out of it, but if that is the case, pitch grouting will pay. We have done 50 miles of tar work this year, and I agree with Mr. Cox that near any city, or where traffic is very heavy, as far as I have been able to judge, tar macadam will not stand. A tarred road with a fine surface dressing is, I think, a thing of the past. Pitch grouting has been found better than rocmac, but it is not absolutely dustless. I still hold, however, that it is the best road for all traffic until horse traffic has not to be greatly considered. Mr. Cox has not dealt with surface tarring at all, but in conversation with the members of the Road Board, the other day, Sir George Gibb favoured it, and pointed out the small cost at which road metal could be produced in Scotland. Under those circumstances, when a water-bound surface can be renewed at 9*d.* per square yard, and in favourable cases at a much lower

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price, Sir George Gibb was clearly of opinion that, for dust prevention, the treatment for country roads, except where traffic is heavy, is surface tarring, rather than the expensive methods of tar macadam or pitch grouting.

The vote of thanks was carried with acclamation.

MR. COX: I have to thank you for the kind way in which you have spoken about my paper. In answer to Mr. Dorman. I may say the low price of rocmac is entirely due to the cheap price of the metal. All the treated roads are within a mile and a half of our quarries. The cost of the metal on the road was about 2*s.* 6*d.* per ton, while the rocmac worked out at about 7¼*d.* per superficial yard extra. Mr. Dorman asked how it rolled down. About the same as water-bound macadam. Mr. Dorman also mentioned about large stones and the filling in of interstices between the stones. I am laying tar macadam, and the stones I am using range from ¾ inch to 2¼ inches in size. I had the honour, like Mr. Robb and Mr. Anderson, of a visit from the Road Board on Tuesday of this week, and they took objection to the size of the stone I was using, and requested me to use a smaller stone. They said it ought to be from ½-inch up to 1½-inch gauge. I must say I did not agree with them. I said that, given a road with little or no traffic, their ideas might be all right, but with any weight of traffic on the roads, I considered their sizes too small. However, as they were paying, they had the right to say what size of a stone should be used, but I hoped they would come back in a year's time to again inspect the road. In answer to Mr. Andrews, who is the pioneer of the rocmac system in Scotland. With regard to the concrete system of laying rocmac, I quite agree with him, more especially where the roads are weak and will not stand excessive rolling. The only difficulty I experienced was that there was a good deal of guesswork in mixing it by the concrete method; you cannot be so careful in doing it as when you spread the matrix on the bottom. Mr. Ronald has mentioned about comparing the English roads with the Scottish roads, and the difference in climate, etc. Now, as a matter of fact, that is what the Imperial Road Board have done. They have gone on the assumption that the conditions are the same here as in the south—that is ridiculous—as they are entirely different, and methods which are all right there are quite impracticable here. When the Road Board went over my district they saw all the rocmac

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roads, and agreed that they were very good. I pointed out to them the difference in the climate and that the rainfall was much greater here than in the south. I asked the Chairman, Sir George Gibb, if they were prepared to give a grant for rocmac, and he said they were not. He also stated that they were prepared to make a grant for tar only. I would suggest that every one who has to-day spoken of rocmac and its good qualities should see that a strong representation is made from their different committees to the Road Board to get a grant for rocmac.

The Members were entertained to luncheon by the Stirling Town Council at the Golden Lion Hotel, Provost Bayne presiding.

In the afternoon the Members were divided into three parties, one visiting the burgh works and the county roads and quarry, a second going to the waterworks at Grangetown; and the third, under the guidance of Mr. D. Morris, Town Clerk, visiting Stirling Castle and other places of historic interest.

In the evening the Annual Dinner of the Scottish District was held at the Golden Lion Hotel. Mr. A. D. Greatorex (President) was in the chair.

A presentation was made to Mr. J. Bryce, Partick, in acknowledgment of his great services to the Scottish District. The presentation, which was made by Mr. J. Holmes, of Govan, consisted of a handsome standard lamp for Mr. Bryce and a gold watch bracelet for Mrs. Bryce.

On Saturday, June 8, the Members attending the meeting enjoyed a delightful circular tour by motor charabancs from Stirling to Lochearnhead, travelling there by way of Callender and Strathyre, and returning by St. Fillan's, Comrie, and Crieff. The party had luncheon at Lochearnhead Head Hotel, and on the return journey a halt was made at Crieff for afternoon tea at the Drummond Arms Hotel.

The meeting was the most largely attended and successful of the Scottish District Meetings.

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EASTERN DISTRICT MEETING.

June 15, 1912

Held in the Town Hall, East Ham.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE MAYOR (COUNCILLOR J. MURRELL OAKES) received and welcomed the Members. The President returned thanks on behalf of the Institution.

THE PRESIDENT referred to the case of Mr. Wm. Jones, who had to defend his good name. Unfortunately, although he won the day, he had been involved in very expensive law courts which could not be recovered from the defendant. The Council had started a mutual defence fund, and proposed sending a circular to all the Members of the Institution, asking them to subscribe to this particular fund. The Council had referred the details of the constitution of the fund to a Committee. It would be worked separately from the ordinary Institution funds, on similar lines to the orphan fund.

MUNICIPAL WORKS AT EAST HAM.

BY J. E. W. BIRCH, *Member*,
ENGINEER AND SURVEYOR TO THE CORPORATION.

1. *Historical.*—East Ham is perhaps the most remarkable example of rapid transformation from a rural to an urban community. Its marvellous growth and development is probably without parallel in the history of the United Kingdom. Thirty years ago it was a straggling village, with a scattered population.

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At that time it possessed neither gas lamps nor sewers. Pavement, kerb, and road formation as now known, were matters of an unknown kind. Trade does not seem to have been brisk. Besides a few shops, there were but two bakers in the village, and one butcher, and the nearest doctor was at Barking. In 1801, its population—including the civil parish of Little Ilford (which is now in the Borough), was 1250; fifty years later it had risen to 1737; and in 1871 to 5009. Since then it has been increasing by leaps and bounds. At the last census the population was returned as 133,504. Like all rapidly growing suburban towns, it has entirely rubbed off its once rural character. From a village of market gardens for the production of cabbages and onions, it has grown into a busy town. It is surprising to see how rapidly building estates have been developed, and in how short a time the area of cultivated fields and meadows has been converted into streets of dwellings. Nor is it in point of population alone that East Ham has developed. With the growth of population, there has been of necessity concurrent progress along the lines of municipal and sanitary developments. The lanes have been widened and converted into important thoroughfares, along which the electric tramcars carry the people to and from all parts of the borough. Fourteen years ago, in the whole district, there were no public buildings worthy of the name. Now there exists a town hall, technical college, and numerous other public buildings.

2. *Industries.*—The chief industry of the borough is that of the manufacture of gas and chemicals by the Gas Light and Coke Company, who employ about 5000 men. The Royal Albert Docks, situate within the borough, also provide employment for a considerable number of men, whilst the remainder (constituting the majority) are of the clerk and artisan class, and find employment in the City of London. East Ham has rightly been described as one of the great dormitories of London. But its phenomenal growth has demanded the reverse of dormancy in its physical developments.

3. *Government.*—In the year 1878 East Ham was constituted a Local Board; in the year 1894 the district was made an Urban District, and in 1904 the urban district was raised to the dignity of a Municipal Borough. The Council consists of six aldermen and eighteen councillors. The borough includes the ecclesiastical parishes of East Ham and Little Ilford, and is divided into six electoral wards.

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4. *Statistics.*—Area of borough, 3326 acres; rateable value for general district rate, 490,000*l.*; rateable value for borough rate, 525,000*l.*; general district rate, 3*s.* 8*d.* in the £ for the year.

Poor rate, including elementary education, higher education (local and county), free libraries, unemployed workmen Act, municipal purposes, relief of the poor, general county purposes, police and overseers, 6*s.* 5*d.* in the £ for year.

Inhabited houses, 26,000; houses erected, 1901–1911, 8507.

Death rate, 12·1 per 1000.

Levels of district, 7·0 O.D. to 50·0 O.D.

5. *Public Buildings.*—A site of six acres was purchased in the centre of the borough in the year 1899, and the following buildings have been erected thereon:—

(*a*) Town hall and municipal buildings (erected in 1901) comprising suites of offices for various departments, police court, minor hall, large hall (with seating accommodation for about 1100 persons), caretaker's apartments, etc., costing 46,054*l.* (price per foot cube, 1*s.* 0½*d.*), from the designs of Mr. Henry Cheers.

(*b*) Adjacent to the town hall is the technical college, erected in 1903, at a cost of 21,676*l.* (price per foot cube, 1*s.* 2½*d.*), from the designs of Mr. Henry Cheers.

(*c*) In connection with the college, there is a well-appointed gymnasium and workshops, erected four years ago at a cost of 2700*l.* (approximately 5¼*d.* per foot cube), from plans prepared by the late borough engineer (Mr. A. Horsburgh Campbell, M.Inst.C.E.).

(*d*) Additions have recently been made to the town hall buildings by the erection of education offices and public health department, mortuary, etc., from designs prepared under the supervision of the late borough engineer, and erected by the Council's own workmen, being completed under the supervision of the Author at a cost of 5600*l.* (price per foot cube 1*s.* 1*d.*). The cost of the mortuary buildings was 450*l.* Especial attention is directed to the simplicity of the mortuary plan.

(*e*) The central Carnegie library is also adjacent to the town hall, and was erected in the year 1908 out of funds provided by Andrew Carnegie, Esq., from designs prepared under the supervision of the late borough engineer, and erected by the Council's own workmen under his supervision, at a cost of 9000*l.* (price per foot cube, 10½*d.*).

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The accommodation on the ground floor of this library comprises a magazine room for forty-eight readers, newspaper room for fifty readers, with lending library at rear with shelves for 20,000 volumes. Also librarian's room and the usual offices. There is a book store in the basement, which has a storage accommodation for 15,000 volumes.

On the first floor there is a ladies' room, with accommodation for forty-eight readers, and a reference room, with accommodation for about twenty readers. Also a room for assistant-in-charge, and small book store and the usual offices. The reference room is connected by means of a lift for the passage of books with the lending library and basement book store.

(*f*) At the rear of the central library there has recently been erected a covered-in public swimming bath. The swimming pond is 120 feet by 40 feet. For a distance of 30 feet from the shallow end, it has a uniform depth of 3 feet, the remainder ranging from 3 feet to 6 feet 9 inches at the deep end, the deepest portion being 8 feet 6 inches over the outlet. The bath proper is constructed of cement concrete retaining walls and floor, the whole being lined with marble terrazzo, and is fitted with the usual accessories of diving board, etc. A series of dressing boxes (seventy-six in all) is ranged along the two sides.

There is seating accommodation for three hundred persons, formed by concrete tiers, finished off with marble terrazzo. This will be supplemented on gala occasions by a temporary wooden tier at the rear for one hundred and fifty, and will thus together accommodate about four hundred and fifty persons.

There are three shower baths, two footbaths, also efficient urinal and W.-C. accommodation.

The apparatus for heating the bath has been installed by Messrs. Royles, Limited, of Manchester, and is on the aeration and filtration principle, thus avoiding the emptying and refilling of the bath with water, the same water being used over and over again. The needful supply of steam is obtained from the electric power station, which adjoins the bath, so aiding in the economy of working.

A small laundry is provided to deal with the cleansing of towels, etc.

The cost of this bath is 8900*l.* (price per foot cube, 6½*d.*), and the work has been executed by the Council's workmen, under the supervision of the Author, from designs prepared under the supervision of the late borough engineer. The plan and internal

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arrangement of the Bath presents certain unique features worthy of observation.

(*g*) Plans for a further extension to this bath, comprising slipper baths and vapour baths have been approved by the Town Council, and forwarded to the Local Government Board for sanction to a loan of 3625*l.*, the plans for this work having been prepared under the supervision of the Author.

(*h*) Plans for a new fire station with firemen's dwellings at rear have also been prepared under the supervision of the Author, and approved by the Town Council, and forwarded to the Local Government Board for sanction to a loan of 8628*l.*

On this same site, there are erected electric power station, tramway sheds and offices, from designs prepared under the supervision of the late borough engineer, and executed by the Council's workmen under his supervision, at a cost of about 26,021*l.* (approximately 5½*d.* per foot cube).

The electrical engineer and tramways manager (Mr. W. C. Ullmann, M.I.E.E., M.I.Mech.E.) has kindly supplied the following particulars respecting these works:—

East Ham Corporation Electric Lighting and Tramways Undertaking.

The electric lighting and tramways undertaking was inaugurated in June, 1901. The generating plant then consisted of four multipolar generators, coupled to cross compound engines, having a total of 1150 I.H.P. The engines were built by Messrs. J. Musgrave and Sons, of Bolton, and the generators by Messrs. The English Manufacturing Co., Preston. The boiler-house plant consisted of four Babcock and Wilcox boilers, each having a heating surface of 3850 square feet capable of evaporating 10,000 lbs. of water per hour. The initial capital expenditure amounted to 66,976*l.* Owing to the increasing demand for supply, the plant has been considerably added to, the first extension consisting of a 750 I.H.P. Musgrave-Dick Kerr engine and generator, the second of a 1250 I.H.P. Musgrave-Dick Kerr engine and generator, and recently a 1750 I.H.P. Browett, Lindley-Westinghouse engine and generator has been installed, bringing the total up to 4800 I.H.P. The boiler-house plant has been doubled, making eight boilers now in use. The total capital expenditure up to March, 1911, amounting to 128,993*l.* The annual output has increased during this period, from 730,642 units generated to 3,895,350

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units, and the revenue from 7094*l.* to 27,604*l.* One of the recent additions has been the installation of a complete new condensing plant of the evaporative type. The condenser has a capacity of 40,000 lbs. of steam per hour, but the air pumps (Edwards') and auxiliaries are capable of working up to a full capacity of 60,000 lbs. of steam per hour. In connection with the electric tramways, the total length of line authorised was 9½ miles, but the length of routes completed at the time of opening was 4½ miles. The rolling stock originally consisted of twenty top-seat single truck cars. At the present time forty-five cars are in use, and the route mileage open 7·6 miles. The capital expenditure has increased from the initial expenditure of 82,978*l.* to 191,158*l.* The total revenue has increased during the period from 15,619*l.* to 55,084*l.* per annum, and the passengers carried from 5,298,476 to 17,668,911.

Owing to the geographical position, inter-running with neighbouring authorities is absolutely necessary in order to meet the public convenience, and the severe competition of motor 'buses which swarm over our main roads. The Corporation cars inter-run with the L.C.C. West Ham Corporation, and Barking Council tramways wherever possible, with good results. The electric lighting and tramways are run as a combined undertaking, under one committee and one management. The following summary will give at a glance the result of the first completed ten years' working of the combined undertakings:—

SUMMARY OF RESULT OF TEN YEARS' WORK TO JUNE, 1911.

	Electricity.	Tramways.	Combined.
	£	£	£
Capital outlay	128,993	191,158	320,151
Total revenue	203,036	422,533	625,569
Gross profit	89,166	114,495	203,661
Per cent. to average outlay ..	7·7 per cent.	7·1 per cent.	7·4 per cent.
Loans repaid and sinking fund accumulated to date ..	33,580	44,958	78,538
Interest on loans	40,821	52,547	93,368
Paid as rates on undertaking	4,708	9,406	14,114
Nett profit	13,463	22,325	35,788
Contributed to relief of rates ..	5,720	14,060	19,780
Depreciation and renewals fund	6,828	4,282	11,110

6. *Libraries*—The Public Libraries Act was adopted by the Council on June 18, 1895, and by a local Act, the Corporation

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is empowered to raise a rate of 1½*d.* in the £ for library purposes.

In addition to the central library before mentioned, the Council possesses three libraries. That at North Woolwich was opened in 1896, and is a freehold corner house, which was purchased by the Council out of revenue. Previous to the opening of the Plashet Library, temporary premises were taken in High Street North, East Ham, which were used for library purposes till the year 1899, when the Passmore Edwards Library in Plashet Grove was opened. This building was the gift of the late Passmore Edwards, Esq., amounting to 4000*l.* The accommodation on the ground floor comprises ladies' reading-room for twenty readers, magazine room for twenty readers, newsroom for about thirty readers, also lending library with shelves for about 18,000 volumes. The first floor of this library is taken up for caretaker's apartments. The Manor Park Branch Library, Romford Road, was erected in the year 1904, out of funds provided by Andrew Carnegie, Esq., from designs prepared under the supervision of the late borough engineer, and erected by the Council's own workmen at a cost of 5000*l.* (price per foot cube, 1*s.*). The accommodation on ground floor comprises a newspaper room for forty readers, magazine room for thirty-six readers, also lending library at rear, with shelves for about 15,000 volumes. On the first floor there is a lecture hall, capable of seating 200 persons, with cloak rooms and the usual offices.

7. *Artisans' Dwellings.*—The Council has purchased fifteen acres of land for the erection of artisans' dwellings, and there are now sixty-six double tenements in Savage Gardens, and forty double tenements in Brooks Avenue. These are let at 6*s.* 6*d.* downstairs, and 7*s.* upstairs, the accommodation provided being a sitting-room or parlour, two bedrooms, living-room and scullery with bath and w.-c. for each tenement.

8. *Fire Protection.*—The present fire station is situate in Wakefield Street, and is well equipped for an old station. In addition to the main station, there is a branch night-and-day station at Manor Park.

The present strength of the brigade is:—One superintendent, one deputy superintendent, one engineer, nine firemen, two coachmen, total fourteen men, four horses (hired).

There is an electric fire alarm system throughout the district. The present number of street alarm posts is sixteen. There are

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also fifteen call-bells to firemen's and turncocks' houses in close proximity to the station.

The equipment of the brigade is as follows:—

One steam fire engine, one manual fire engine, one horse-drawn escape and hose tender, two hand-drawn escapes, four jumping-sheets, six handpumps and hose, 3500 feet of canvas hose, one smoke helmet, eight scaling ladders.

9. *Parks and Pleasure Grounds.*—Central Park has an area of about twenty-five acres, containing cricket pitches, football grounds, bandstand, bowling green, and tennis courts. The bowling green (consisting of six rinks) was laid out by labour provided by the Distress Committee. The tennis courts are constructed on the hard surface principle, and finished off with the En-Tout-Cas Tennis Court Company's material.

Plashet Park has an area of 18 acres, and is laid out similarly to Central Park, including a bowling green, which was also formed by Distress Committee labour. The tennis courts in this park are of turf.

Beckton Park has an area of 13 acres, and contains cricket pitches, football grounds, and general playing fields.

Wanstead Flats, with an area of about ninety-six acres (in so far as within the borough), are situate in the northern portion of the borough, and at the southern extremity of Epping Forest. They are vested in the City of London Corporation, East Ham Corporation having control by arrangement. The borough has provided a bandstand and numerous cricket and football pitches, also tennis courts.

North Woolwich Gardens have an area of about eight and a half acres, and are situated in the southern portion of the borough, on the bank of the River Thames. They are maintained by the London County Council, the borough of East Ham contributing towards the initial cost of purchase.

Barking Road, Greatfield Estate, Little Ilford, and Vicarage Lane Grounds (a total area of about twenty-six acres), are laid out as playing fields for children.

The foregoing parks and playing fields provide a total area of 186½ acres of open space within the borough, to a population of approximately 140,000 persons, and an acreage of 3326.

10. *Open-air Swimming Bath.*—In the year 1902, the Council constructed by direct labour, at a cost of 1200*l.*, an open-air swimming bath in the south-east corner of Central Park. The

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size of the swimming pond is 90 feet by 30 feet, and at the deep end has a depth of 6 feet 6 inches and at the shallow end 2 feet 6 inches. It is constructed with cement concrete retaining walls and floor, the whole being lined with terrazzo. The bath is fitted with the usual accessories, and is surrounded by fifty dressing boxes. The pleasure of a swim and a run in the open when the weather is favourable is a feature of the open-air bath, which the covered-in bath fails to provide.

11. *Hospitals.*—In the year 1900, seventeen acres of land were purchased in the south-west part of the borough, and the temporary corrugated iron building, which for several years had been situate at Bonny Downs, near the Sewage Works, was removed to the new site in 1901. Two years later, an additional corrugated iron building was erected for diphtheria and scarlet fever. In the year 1906, the late borough engineer was instructed to prepare a scheme for the provision of permanent buildings. This complete scheme provided for one hundred beds, at a cost of 48,000*l.*, ranged in a series of separate pavilions. The first of these pavilions was erected at a cost of 140*l.* per bed, or 5¾*d.* per foot cube, the accommodation being for twenty-six beds. The laundry and porter's lodge were built at the same time. In the year 1908, a further block of two storeys was erected, the accommodation on ground floor being for twenty beds, the upper floor being used for nurses' sleeping quarters, etc., the cost being 4500*l.* (approximately 6½*d.* per foot cube). Also an observation block, built on the cubicle system, containing twelve beds, with glass partitions dividing the beds, the cost being 1680*l.*, or 140*l.* per bed, or 8*d.* per foot cube. The arrangement and economy of this plan, both in first cost and in working, commends it to notice. A bungalow for resident medical officer has also been provided, also complete laundry, disinfector, stabling, and ambulance accommodation is provided on the site. One of the corrugated iron buildings has now been converted into a shelter for the treatment of consumption, and a portion of the last erected iron building is also used for the same purpose.

12. *Road and Highway Maintenance.*—There are 66 miles of public highways within the borough, 6½ miles being county main roads. These latter are maintained by the Corporation under agreement with the County Council. On all the main roads there is a very heavy traffic. Especially is this the case in Romford Road, it being the main thoroughfare between London and

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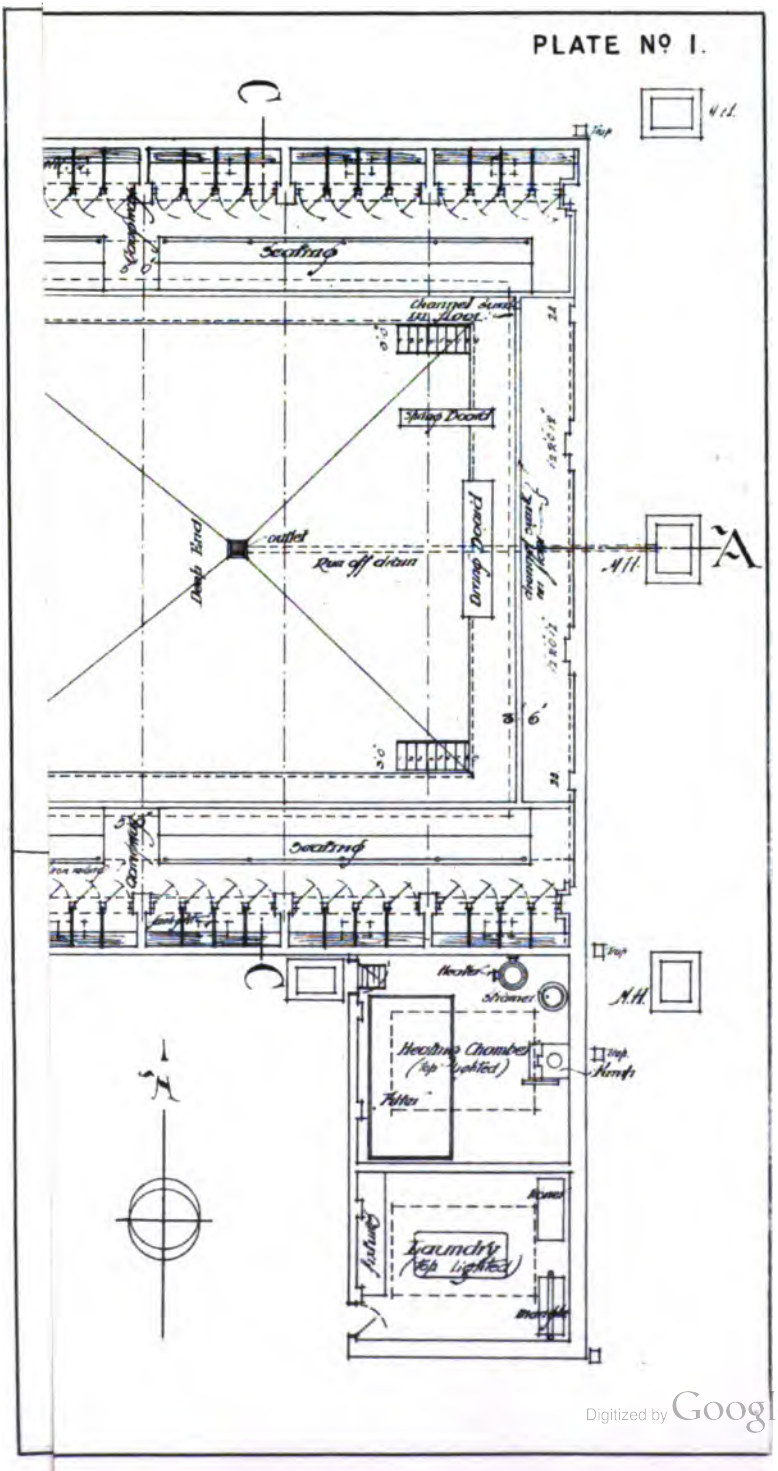

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Colchester. The scavenging and maintenance is carried out by direct labour, the horse haulage being carried out by contract. The wage of roadmen is 30*s.* per week for forty-eight hours. The Corporation owns thirty-two water vans, the haulage of these being carried out by contract. The number of metered hydrant stand posts is sixty-eight, the charge for water being 6*d.* per thousand gallons. The water is obtained from the Metropolitan Water Board. For the purposes of scavenging and road watering, the borough is divided into two districts, each being in charge of a road foreman (wage, 50*s.* per week). The cartage of road sweepings and slop is carried out by contract, and costs approximately 1550*l.* per annum. All streets are 40 feet wide, except the main roads, which are from 50 to 60 feet wide. In each of the main roads, there is a line of tram-track, the maintenance of this, including 18 inches on each side of the outer rails, is carried out by the borough engineer's department on the requisition of the tramways manager, and at the cost of the tramways undertaking. Within the borough are 2 miles of wood-paved roads, 1 mile of granite-paved roads, 5½ miles of granite macadam roads, 2½ miles of tar macadam roads, 55 miles of flint roads.

The attention of the Institution is called to the paving of the Barking Road with sectional hard-wood blocks, 3¼ inches in depth, laid from two to three years ago, which promise to give excellent results, particularly in relation to the tramway track, and the side margins. The total area of paving so laid is about twenty-five thousand square yards of roadway and tramway.

There is also a short piece of Val de Travers bituminous grouted macadam roadway, which cost about 3*s.* 5*d.* per square yard to lay. Roadoleum has also been laid at a cost of about 2*s.* 10¼*d.* per square yard, these prices include scarifying, laying three inches of broken granite and grouting with binder. All the flint roads are water bound. "Glutrin" has been used in formation and repairing side roads, this material being used in conjunction with pit ballast, blue lias lime, and chalk rubbish, the cost working out at about 1*s.* 4*d.* per square yard, inclusive.

During the past ten years, about twenty-one miles of private streets have been made up by direct labour under the 150th section of the Public Health Act, the average cost being 9*s.* 4½*d.* per foot of frontage.

The carriageway is finished off with Kentish flints, and the footpaths in granolithic, laid *in situ*. The granite kerb is

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provided by the estate owner when the street is laid out, and is taken up and relaid on cement concrete at the time of making up. The granite channel is provided and laid on Portland cement concrete and included in the cost of making up.

13. *Sewerage and Sewage Disposal.*—The drainage of the district is partly on the "separate" system, the surface water flowing to the watercourses, and the sewage to the Council's own works and pumping station.

The following particulars are kindly supplied by Mr. A. Horsburgh Campbell, M.Inst.C.E., the engineer responsible for the sewage works:—

East Ham Sewage and Refuse Disposal Works.

The sewage disposal works were originally provided for a population of about 20,000 people, when first laid down upon the designs of Mr. Charles Jones, M.Inst.C.E., and Mr. W. H. Savage, A.M.Inst.C.E., the first surveyor of the district. They were opened in 1886, and had to do duty in their original condition until 1902. At this time, the population had grown to nearly 100,000 persons and the demands were seriously disproportionate to the means available. A proposal was submitted for connecting the outfall drainage with the London County Council's outfall sewer at Beckton. Subsequently, however, owing to the difficulty of ascertaining from the London County Council the terms upon which they would receive the sewage of the borough, and other local causes, it was decided, upon the advice of the late borough engineer, to at once proceed with the adaptation and extension of the then existing works and pumping plant, so as to bring those original works up-to-date and to make them available for a population of at least 150,000 persons. To this end, the enlarged pumping station was built; new pumping plant provided as per particulars following; a refuse destructor for the supply of steam was introduced; the precipitation tanks were enlarged; three acres of bacterial filters were provided; the latest addition being a humus basin or tank (one acre in extent) for the final purification of the filtered liquid. These works (involving an expenditure of 44,000*l.*) were carried out by direct labour, aided, as regards the filters and humus basin, by distress labour. Certain features in the arrangement and operation of these works are worthy of notice, viz.:—

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(1) The completely self-contained nature of their design and operation, that is to say, a perfect cycle of operations is realised; in that the power needed to pump the sewage and to do the other incidental duties of purification is provided by the crude refuse of the town, burned in the destructor, the resultant clinker being in turn used for the subsequent purification of the effluent.

(2) Another feature of the works is the great extent of natural aeration of the sewage at its various stages of purification by extended weirs at every stage, and undoubtedly the results obtained are attributable in a very large manner to this free exposure of the liquid to the natural agency of sun, light, and air.

Those results—in point of low capital and working cost, and the results obtained—amply justify the wisdom of the Council's decision in utilising their own works and in retaining the control of this important adjunct of local sanitary administration. Appended hereto is a table of the analysis of the crude sewage, and of the final effluent, which standard may be said to be consistently maintained.

On arrival at the works, the sewage passes through a screening chamber, equipped with penstocks, byepass, etc. On each main sewer there is a manhole containing a fixed screen, 8 feet by 6 feet with vertical bars $\frac{1}{2}$-inch apart. These screens are cleaned by means of travelling rakes, which lift the screenings to a trough above ground-level.

The rakes are cleaned automatically by a patent rake-cleaning gear. The whole of the mechanical part of this work was supplied by Messrs. Stott, of Haslingden. The power for driving same is supplied by means of a $3\frac{1}{2}$ H.P. vertical engine, connected by shafting from the engine house. The sewage next flows to a pump well beneath the engine-house floor, from which it is pumped into precipitation tanks. The pumping plant for the crude sewage consists of two direct-coupled "Allens'" 25-inch twin centrifugal pumps, each capable of delivering 20,000,000 gallons per day, driven by high speed (460 revolutions per minute) 165 B.H.P. forced lubricating condensing engines, steam being supplied at a pressure of 150 lbs. per square inch, and one 12-inch centrifugal pump, gear driven by 45 B.H.P. motor capable of delivering 6,000,000 gallons per day. A 126-kilowatt electric generating set, by Mather and Platt, working at 230 volts, is installed for the purpose of providing electricity to light the

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works, to pump the tank effluent on to percolating filters, and also to provide energy for driving the 12-inch centrifugal pump in engine house. The total height the sewage is lifted from the normal water-level of the pump well into the tanks is 32 feet. As it flows into the tanks, the sewage is treated with lime, nine grains of which is applied to each gallon of sewage. There are two continuous-flow precipitation tanks, 155 feet by 24 feet 6 inches by 7 feet average depth below weirs. Only one tank is in use at a time during dry weather. Each tank is cleaned out once weekly. The effluent from these tanks is treated with ferric sulphate in liquid form, to the amount of 4·7 grains per gallon of sewage. It then flows into one of the three quiescent tanks, each 200 feet by 50 feet by 7 feet average depth, and is allowed to rest in same for two to three hours. One tank is cleaned out each week. Provision is made for gravitating the tank effluent back to the pump well, and retreating it if found necessary. The final tank effluent is pumped by an electrically driven centrifugal pump, capable of delivering 6,000,000 gallons per day, into a cast-iron pipe, 15 inches in diameter, reducing to 12 inches and 9 inches in diameter, which encircle the filter beds. From these pipes, distributing pipes, 4 inches and 3 inches in diameter, are laid in lines at intervals of 8 feet across the bed, and "fixed sprays" are fitted on these pipes at 9 feet distances apart. The sprays are of two types, one made by Messrs. Jones and Attwood, of Stourbridge, and the other made by Messrs. Stone and Co., of Deptford, and patented by Mr. Carpenter, the engineer and manager of the works. The filters are composed of refuse destructor clinker, broken to a gauge of 2 inches to $\frac{1}{2}$ inch, one filter being 6 feet deep and one 4 feet 9 inches deep. The dry-weather sewage is applied at the rate of 162 gallons per cubic yard per day.

A contact bed, one acre in extent, three feet deep, the medium being broken clinker, is provided to purify the supernatent water drawn off from the quiescent tanks. The bed is only filled twice a day, the tide preventing the use of this bed in three cycles of eight hours each per day. The effluent from these beds flows through a humus basin—one acre in area. It enters at one corner, and flows by a circuitous route over four weirs, to a pipe discharging into the main effluent drain. The object of the humus basin is to allow any suspended matter in the filtered effluent to settle, and at the same time to aerate

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BOROUGH OF EAST HAM.

TABLE OF ANALYSES OF SEWAGE EFFLUENTS, ETC.

These figures refer to grains per gallon.

Number.	Date.	Source.	Colour.	Odour.	Suspended matter.	Degree of Oxygenation.	Nitrogen in nitrates and nitrites.	Free ammonia.	Organic ammonia.	Oxygen absorbed in 3 hours.	Impurity figure.	Degree of purification.
											Per cent.	Per cent.
1	13 Sept.	Crude sewage	Brown	Of sewage	44·3	Nil	Nil	7·5	1·0	7·4	100	Nil
2	13 Sept.	Tank effluent	Cloudy	Urinous	5·1	7·5	Trace	3·7	0·40	2·2	30	70
3	13 Sept.	Filter	Pale yellowish	Earthy	1·4	10°	1·1	1·8	0·09	1·0	14	86
4	13 Sept.	Humus tank	Pale yellowish	Earthy	1·2	10°	1·4	1·2	0·05	0·8	8	92
	IDEAL STANDARD:		Clear	Nil	—	10°	As high as possible	—	0·10	1·00		

The above samples consisted of definite quantities taken every half-hour, between 9 a.m. and 6 p.m. inclusive, which, at the end of the day's working were thoroughly mixed. Average samples were then taken and analysed.

(Signed) E. WARNER, Works Chemist.

Remarks by Engineer:—

1. A domestic sewage, moderately dense.
2. Putrifies after three days.
3. No putrefaction, but a good deal of mineral deposit from filter.
4. Final effluent decidedly clearer than No. 3; absolutely non-putrescent. Suspended matter is fine particles of clay from unfinished basin.

A. H. CAMPBELL, M.Inst.C.E., Borough Engineer.

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same as much as possible. The main effluent drain, 4 feet in diameter, discharges into the tidal River Roding, at low water level. The sludge from the precipitation tanks is swept out by means of squeegees through 12-inch valves into a sludge conduit, and thence to a pump well, whence it is pumped by two Tangyes' horizontal direct-acting pumps into a timber trough, along which it flows at a gradient of 1 in 90 to a lagoon, formed with banks of house refuse on the marsh.

The quantity of sludge pumped is about 1050 tons weekly. The above sludge covers an area of about one acre, 7 feet deep per annum. The total area of the works is about 56 acres, of which 18 acres are still available for the disposal of the sludge.

Refuse Destructor.—The refuse destructor adjoins the sewage disposal works, and contains two units of three cells each, Meldrum's "Simplex" front-feed destructor. Forced draught (hot air) is supplied from two regenerators, each of 264 tubes, and 1100 square feet of heating surface. The grate area of each unit is 80 square feet. Attached to one unit is a Lancashire boiler, 30 feet long by 8 feet 6 inches diameter, with 1100 square feet of heating surface. To the second is attached a Babcock and Wilcox water tube-boiler, 2255 square feet of heating surface. An auxiliary grate is fitted to the Babcock and Wilcox boiler, thus enabling coal to be burned if the refuse is very wet or too poor in quality to generate the steam required for the works. The units are worked alternately, one working whilst the other is being cleaned, thus giving a continuous working of 168 hours per week.

The weight of refuse daily destroyed is from 50 to 60 tons the average weight of the refuse in summer being 6 cwts. per cube yard, and in winter 9½ cwts. per cube yard. The present chimney shaft is 100 feet high, and a new one is being erected 8 feet internal diameter and 150 feet high.

Capital Cost of Works.	£
Tanks and original buildings	21,000
Alterations to same	2,000
Destructor, two units of three cells each, boiler plant, approach roads and foundation work	12,500
Outfall to River Roding	5,000
Filters (2 acres) complete	7,000
New pumping plant, deep well, screening gear, etc.	12,000
Humus basin and contact bed	4,000

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Number of Men employed.—The number of men employed is thirty-six, viz.:—

(*a*) On sewage pumping and purification: one manager, three shift engineers, three engine drivers, one fitter, three chemical mixers, one sludge pump man, three tank men.

(*b*) On destructor staff, working in three relays of eight hours each: six stokers, six trimmers, one cleaner, two carmen.

(*c*) Miscellaneous duty: six general labourers; total, thirty-six. Total weekly wages amount to approximately 70*l.*

Annual working cost, 6975*l.*, made up as follows:—

	Totals.	Whereof for:		
		Destructor.	Pumping.	Sewage purification.
	£	£	£	£
Wages	3650	1507	1002	1141
Cartages	300	250	—	50
Buildings and plant (repairs and renewals)	400	150	100	150
Coal and coke	400	—	300	100
Sewage precipitants	1250	—	—	1250
Stores	300	60	150	90
Rates, taxes, and insurance ..	220	100	50	70
Roads and fencing	125	60	5	60
Contingencies	330	100	100	130
	£6975	£2227	£1707	£3041
Equivalent to rate burden per pound of rateable value, approx.	3·42*d.*	1·09*d.*	0·84*d.*	1·49*d.*

Cost per head of population, inclusive of pumping and refuse cremation, about 1*s.* per annum.

14. *Workshops.*—Some years ago the Council were able to purchase at a very reasonable figure a range of corrugated iron buildings, which were conveniently adapted so as to form ranges of workshops, cart shedding, and stores. These are erected on land adjacent to the sewage works. A storekeeper's office and weighbridge are provided at the entrance.

15. *Conveniences.*—Situate at junction of the main roads are two underground sanitary conveniences, one being in the centre of the borough, the other being at the northern end. The erection of further conveniences in other parts of the borough is now under consideration.

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16. *Lighting.*—The borough is lit both by gas and electricity. The main thoroughfares are lit with arc lamps, and the side streets by electric glow lamps, and with incandescent gas lamps.

The gas lamps are fitted with incandescent mantles, burning $2\frac{3}{4}$, $3\frac{1}{4}$, 4, and $4\frac{1}{4}$ feet per hour respectively. The current is supplied from the Council's electric generating station, and the gas by the Gas Light and Coke Company, the lighting, extinguishing, cleaning, repairs and maintenance both of gas and electric lamps being undertaken by the Council's workmen. The wages of lamplighters are 26*s.* per week and uniform.

17. *Dust Collection.*—This work is carried out under the supervision of the chief sanitary inspector. The Corporation owns the dust vans, and employ the dustmen direct, but the horse and driver are contracted for, the amount of the contract for the current year being 2750*l.* The collection is made once a week, the whole being carted to the refuse destructor.

18. *Workmen.*—The number of men regularly employed in the engineer's department is about three hundred and fifty, this number including those engaged on scavenging, sewer work, street works, parks, sewage works, and workshops. Each man is allowed Bank holidays, with pay, and one day annual holiday for each two months' completed service, such holiday not to exceed one week.

Sick Pay.—After twelve months' service each workman is allowed two weeks' full and two weeks' half pay in any one twelve months. The average working hours are forty-eight per week, with a minimum wage of 30*s.* per week for a man twenty-one years of age. The mechanics are paid the Trades Union rate of wages, and work the hours of labour as laid down by their respective Unions.

The Author desires to acknowledge the very able and willing assistance rendered by his deputy, Mr. Baker, the chief assistant, Mr. Brook, and the engineering assistant, Mr. Bridgewater, together with the general staff of the department, in the carrying out of the various undertakings of the Corporation.

DISCUSSION.

MR. E. WILLIS: I should like to propose a very hearty vote of thanks to Mr. Birch for preparing this paper. It is submitted in a most condensed form, and one in which it is most useful

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to the Members. I should like to congratulate the borough of East Ham, upon its abnormal development, and especially on the lowness of its general district rate. I notice the poor rate is not low, to put it mildly, since the combined rates amount to 10*s.* 1*d.* in the pound, but the general district rate, considering the development of the town, has been kept at a very low figure indeed, and the officers also are to be congratulated on this, bearing in mind the many improvements and the excellent buildings they have to show for it. The municipal buildings and town hall seem to be ideal from the point of view of centralisation. In connection with the library we are told that the Council are permitted to raise a three-halfpenny instead of a penny rate, which most of us have not the privilege of raising under the ordinary Library Acts. May I ask if it has been necessary to increase the rate beyond a penny, and if so, whether the Council have expended to the utmost of their powers? I am also surprised to see that the expenses of the library come out of the poor rate. I cannot quite understand this. Can Mr. Birch give us the cost of administering fire protection throughout the Borough. Looking at the map the district appears to be very elongated, and I should like to know whether the ordinary equipment and horse haulage is the best for a district of considerable length, or whether motor traction would not be more efficient from the speed with which the appliances could reach the buildings on fire. It is also desirable to know the cost of this particular department. The cost of the open-air swimming bath seems to be rather high, unless there is something abnormal in connection with this work. I know another case in which the area of the bath was three times as great, and the cost was not half as much. It may be that there are some special points which account for same, such as building by "casual" or "unemployable" direct labour. I should like to know whether there is more than one block of the hospital designed by Mr. Campbell, of which the design is registered. Mr. Chas. Jones has been connected with many sewage and other works, in various parts of the country, and he was, in conjunction with Mr. Savage, the pioneer of these works. It proves the excellence with which they were designed and carried out, that they have been able to cope with a population of 100,000 before reconstruction became necessary. I cannot quite find out the daily flow per head of population. It seems to me if these works coped with a population of 100,000,

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the daily flow cannot be very heavy, and this may be due to East Ham being a dormitory for London. Then with regard to the analysis, we are told that an ideal standard includes 1 grain per gallon of oxygen absorbed in three hours. I am afraid I have always aimed at something very much better for an ideal standard. Possibly it was intended to be set forth as an "ordinary legitimate standard" and not an "ideal."

MR. REG. BROWN: I have pleasure in seconding the vote of thanks. I should like to ask what method is adopted in the borough to communicate with the firemen under the control of the Council, whether the firemen are housed in a separate building or whether the men live in various parts of the borough. Difficulty of communication is most important, especially where the horses are hired. I do not agree that 1200*l.* is an excessive sum for an open-air bath. Nowadays such a bath as that described in the paper would cost considerably more, as many recent Acts of Parliament would increase the cost. I should like to ask whether the bath is of ordinary construction or on the ferro-concrete system. The information in regard to highway maintenance is extremely interesting. East Ham is in the position of being on the extreme east of the extra Metropolitan area, and it would be very advisable for them—almost essential for their development—that there should be a better means of communication between the north and south sides of the Thames. At the present time there is a scheme in hand in the east end of the district in connection with the docks, and if the Corporation can see their way clear to approach the dock authorities to get a connection between East Ham and the south side of the river by means of a subway for vehicular traffic, it would prove of benefit not only to East Ham but to London generally. In my view, it was a short-sighted policy when the Woolwich subway was constructed not to have done more. They ought to have constructed a carriageway as well as a footway for foot passengers, and so dispense with the necessity for the free ferry. The results shown in respect of the sewage disposal works are admirable. The ideal standard referred to is a very good one. It is not quite what one may get in some works, but if every authority could get such a standard, there would be no reason for complaint, because the river Roding, into which the effluent is discharged, is not a very large one, and is largely composed of sewage effluent, not only from East Ham, but from other authorities.

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MR. W. L. BRADLEY: It might be interesting to the members to know what the pressure is in the water-mains, because it seems to me the district is a fairly flat one, and the question of motor traction may not apply, for there may be sufficient pressure in the mains to practically do without a steamer or other methods of dealing with fires. With reference to the swimming bath, it seems to me the amount of 1200*l.* is rather heavy, but, before seeing the bath, it is difficult to express an opinion about it. Another point is whether anything has to be paid for water, how it is obtained and changed, and whether it has to be pumped in or out. There may be reasons for what seems this excessive cost.

MR. A. C. JAMES: As to the roads, I should like to know how roadoleum and glutrin stand during the winter months. With regard to the cost of private streets, I presume the cost does not include the kerb and the surface-water drains which were put in them before by the owners. If Mr. Birch could give us the amount of the cost per house per annum for collection of refuse it would be useful.

MR. E. H. ESSEX: The general district rate is 3*s.* 8d., and the poor-rate 6*s.* 5*d.* in the pound. At Leyton the general district is 3*s.* 3*d.* and the poor-rate 5*s.* 8*d.* in the pound. It is a shocking state of things that the poor-rate should be so high. Mr. Birch will be able to explain that the education rate is very heavy in this part of the country. When Mr. Birch sees that the general district rate at Leyton is 3*s.* 3*d.* in the pound, he can see before himself a large field for possible reduction. His street lighting costs him 77*l.* a mile, and mine costs 107*l.* That means a penny rate in my district. With reference to fire protection, I have had to look into the question of motor-propelled instead of horsed vehicles, and the report showed a very great saving in motor-propelled vehicles compared with horse-driven vehicles in this particular locality. We have not many hills to cover. With regard to street water, I should like Mr. Birch to look into this carefully and let me have the number of loads of water per van per day. I suggest that the loads per van should be 24, and the loads per mile should be four with roads of 40 feet width. We are told that the cartage of road sweepings and slops is carried out by contract, and costs approximately 1550*l.* per annum. I would urge upon members of the Institution that when they give us these facts, they should give them in the

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form of charts. Then we are told, as to sewerage, that the district is partly on the separate system, the surface-water flowing to the watercourses and the sewage to the Council's own works and pumping-station. That word "partly" is a thing we can all think about. Does Mr. Birch mean that only the front roofs are drained into the surface-water drains, or in some parts of the district are both the front and back roofs drained separately from the sewers? The attempt to drain back premises separately is a mistake. With regard to the work carried out by distress labour at the sewage works. Labour is at times a distress to those who have to labour, but I think in this particular case the distress falls upon the unfortunate individual who has to supervise it.

MR. CUBITT: Under the head of fire protection, Mr. Birch has given us a statement of the fire station and its equipment down to the number of feet of hose, but I think, under such a head, the question of fire prevention comes in. Although I understand that East Ham is now happily called the dormitory of London, that is hardly likely to be the case in ten, fifteen, or twenty years' time. There is a tendency for manufacturing businesses to move out, and it is reasonable to suppose there will by that time be a good number of manufacturing and trading premises in this district. In London itself the fire preventive precautions are not confined to carrying party walls through the roofs of buildings, but there is also a requirement that all businesses carrying on manufactures are to be cut off into partial divisions. I believe the only other town where such a provision applies is Glasgow. I think the reason why for fifteen years we have not had a big fire in London is that the big buildings in which such fires start are cut off into divisions. Mr. Birch may be well advised to get his local Council to consider the desirableness of putting in some provision requiring these very big buildings to be subdivided. I think it is quite possible that in the course of time East Ham may be in the county of London, and, if so, subdivisions would apply. It is only fair, I think, to look a little ahead and see if the buildings which are put up could not be brought into line with London. East Ham is as much part of London as other parts in the county, and more thickly populated than Eltham or Roehampton, and it is more reasonable for this regulation to apply in East Ham than in one-fourth part of the London county area.

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MR. C. JONES, General Honorary Secretary: You will not expect me to enter into critical discussion or remarks on this paper. I have been deeply interested in what I have seen, and I cannot but congratulate Mr. Birch and such members of the Council as are here, upon the very satisfactory condition of affairs in East Ham. There are very few here who realise that, perhaps, so thoroughly as I do. You have seen what has been written in the paper about my work here. It was my privilege nearly thirty years ago to be associated with my friend Mr. Savage in laying down the first system of drainage that was carried out in connection with East Ham. That was in the year 1884, and I think the completed works were handed over in 1886 or 1887. It is a source of gratification, and I am sure every worker here will realise what I mean when I say that it is a gratification to come into the district nearly thirty years after to find the system still in successful operation, and all that has been done has been an extension of the system on the principle laid down, so as to meet the requirements of the growth of population. That the system continues to work well, while the population has increased from 20,000 to 100,000, could not but be gratifying to those who had to do with the designing and carrying out of the scheme. I am sure that appeals to every earnest worker who has any degree of that human nature and natural pride in the success of our work which, I presume, we all have more or less. When I visited the borough some few months ago to say good-bye to my friend, Mr. Campbell, on his departure for Edinburgh, I was astonished at the changes which have taken place. The splendid collection of buildings, of which your magnificent town hall is a central feature, is sufficient to indicate the progress which has been made. When you are in earnest in your work, when you are prepared to spend money in a reasonable and proper way, and in cultivating the highest principles of art, it is a moral lesson to the community. I mention this because I have heard criticism of East Ham as being extravagant. I do not believe it. My district differs from this, because the character of the district is different, and the rateable value is 7*l.* or 7*l.* 10*s.* per head. You cannot help the fact that yours is 4*l.* I have no sympathy with those who are constantly carping at a little more on the rates. Do the thing, and do it well, and I think the Council of East Ham are endeavouring to do their work well, and I know that in the end the work they

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have done will redound to their honour and peace of mind as well. I may say that of the several towns I have had to deal with there are none I can look back upon, and feel better satisfied with the work that has been carried on so successfully. In Mr. Savage, Mr. Campbell, and Mr. Birch you have men who have done honour to the profession, and who will do well in that which is committed to them in East Ham, or wherever their lot may be cast.

MR. J. E. W. BIRCH, in reply: I will endeavour to answer some of the questions. With regard to the cost of the open air bath, when this bath was constructed by Mr. Campbell it was thought probable that a roof might be placed on the walls, and therefore the walls were made of such strength so as to carry a roof if required at any time. The design which Mr. Campbell has registered in connection with the isolation hospital is that of the cubicle block. The one advantage in same being that in the nurse's duty room there is an observation window, from which the nurse can get a view of each patient, the cubicles being divided by plate glass, so that the nurse has no need to go outside to see if any patient requires her attention. As to the flow of sewage per day, the dry-weather flow is $3\frac{1}{4}$ million gallons, which will give something like 26 or 27 gallons per head per day. Motor traction in connection with fire brigade administration, has been considered by the Council, but nothing definite has been arrived at as to whether they will have motor traction. The horses are housed alongside the fire station, so they are ready at a moment's notice; there is no waiting for them. The firemen are housed within a few yards of the station, and the houses are connected with the station by electric call bells, so that from the time they receive the call the engine can leave the station in two minutes; so I do not think there is very much time lost in getting ready to arrive at any fire. The access way across the Thames has been mentioned by Mr. Brown. Undoubtedly this requires very careful attention, and watching that in the dock extension provision is made if possible for a better intercommunication between the south and the north of the Thames. The Council are quite alive to this fact, and have already considered it. The pressure in the water mains I cannot give; in most instances when attending a fire it is not necessary to use the steam fire engine, the pressure being enough from the hydrants to deal with the fire. It is only in extreme cases

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that it would be necessary to use the fire engine. The pressure at night is always above what it is in the day. The water in the open-air bath is found necessary to be changed twice a week in the summer. A vegetable growth appears in the water, so that if the water remains in the bath more than a week growth begins to show itself on the sides of the bath. As to roadoleum and glutrin, I have used roadoleum on the High Street in front of the Town Hall, but am afraid it has a tendency to get loose. Glutrin I have used with ordinary pit ballast. It costs 4*d*. per yard super more than the ordinary water-bound road. I am watching to see if I am getting that amount of value over the ordinary water-bound road. It is not dustless, but it saves rolling, and gives a very nice finish to the road. One portion has been down for about twelve months. I was pleased to hear Mr. Essex give figures as to the loads and work of water vans. There have been numbers of devices to check the loads, and that is where the difficulty comes in. You must rely upon the honesty of the carmen. I have seen tell-tales put upon the vans; but I have heard of the men causing them to record without putting the water on the road. Unless you have some one walking behind the cart all day long, I fail to see how you are going to get the exact number of loads without trusting the word of your carmen as to the number of loads which they have put on the road. My experience of carmen is that they know what constitutes a day's work, or what is expected of them. The question of the separation of our sewers: I may say all the water from the front roofs discharges into the water channels of the roads, the water from the whole of the back roofs enters the foul drainage. East Ham, when first sewered, had only one sewer laid in the main thoroughfares, and that causes only partial separation. Duplicate sewers are laid in the side streets discharging into one sewer in the main streets. The Corporation has now in hand the construction of duplicate sewers in the main streets in order to pick up the surface water from the side streets and discharge same into the watercourses, and thus save pumping at the sewage works. Mr. Essex mentioned the distress labour. This is labour supplied by the distress committee. The men did the best they could, but I do not want them on the sewage works again. I have to thank you for the way in which you have received and discussed the paper. It is by this means that we may learn from one another the best and the most economical way to do things in order to give the best results.

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The Members made visits of inspection to the Town Hall, Public Baths, Library, Mortuary, School clinic, the Electric Power Station, and Barking Road sectional wood block paving.

The Members were entertained to light refreshments at the Town Hall.

In the afternoon the Members drove to Manor Park Library, the Central Park, and Open-air Swimming Bath, the Isolation Hospital, and the Sewage Works.

At the conclusion of the visits Mr. J. E. W. Birch entertained the Members to tea at the Town Hall.

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EASTERN DISTRICT MEETING.

June 22, 1912.

Held in the Town Hall, Lowestoft.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE MAYOR (COUNCILLOR T. E. THIRTLE) welcomed the Members to Lowestoft. The President returned thanks on behalf of the Institution.

TWENTY-FIVE YEARS' MUNICIPAL WORK AT LOWESTOFT.

BY G. H. HAMBY, ASSOC.M.INST.C.E., *Member*,
BOROUGH ENGINEER, LOWESTOFT.

LOWESTOFT is pleasantly situated on the coast of the North Sea in the county of Suffolk, about one hundred and sixteen miles from London *viâ* Ipswich and East Suffolk branch of the Great Eastern Railway, 10 miles south of Yarmouth, and 23 miles south-east of Norwich. The town stands upon the most easterly point of England, and commands an extensive view of the sea. Lowestoft can claim antiquity, as it is said to have been a fishing station as early as the time of the Romans, but the ancient town was washed away at an early period by the ocean, for there was to be seen till 1534 the remains of a blockhouse, left dry at low water, about half a mile from the present beach. The origin of its name has given rise to various guesses not worth notice. In a Charter of Edward III. it is written Loystoft and Lowystofte. Being an ancient demesne of the Crown, it obtained

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from several monarchs various privileges, which were confirmed by Elizabeth and Charles I.; but they are now obsolete. The Lowestoft Improvement Act was passed in the year 1854, entitled, "An Act for the improvement and regulation of the town of Lowestoft and the parishes of Lowestoft and Kirkley, and for other purposes." Its powers were entrusted to twenty-seven Commissioners. The Public Health Act, 1875, constituted the Commissioners a Sanitary Authority. In 1795, 1801, and 1805, certain lands containing about forty-two acres, called the Lamp Lands, were vested with trustees for paving and lighting the town. The original trustees of the Lamp Lands obtained an Act in 1810 for paving and lighting the town under a body of twenty-four Commissioners, who were called the Town Commissioners, and when they surrendered their trust to the Commissioners of the New Improvement Act in August, 1854, their debts amounted to about 1800*l.* In 1885 the town obtained a Charter of Incorporation, the borough being divided into four wards—north, south, east, and west, with six councillors and two aldermen for each ward, making a council of thirty-two members.

General Statistics.—The town is about three miles in length from north to south, and two miles wide from east to west. The surface level of the lowest street or road is 6 feet above O.D., and the level of the highest street is 92 feet above O.D. The subsoil is boulder clay in the west part of the town, and sand and gravel generally in the other portions of the town, except a small area of boulder clay south of Kirkley church. The area of the borough is 2574 acres (including land covered by water). The following table shows the growth of the borough during the last fifty years.

RATEABLE VALUE.

Year.	Population.	Poor rate. £	Gen. dist. rate. £	Number of houses.
1861 ..	10,663	—	—	2,290
1871 ...	15,249	38,930	38,930	3,070
1881 ..	19,696	69,097	55,203	4,360
1891 ..	23,347	86,372	84,977	5,241
1901 ..	29,850	127,565	118,175	6,557
1910 ..	33,514	147,286	136,494	8,965

The rates during the last twelve years have been as follows:—

	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
Gen. Dis. Rate	4/-	4/2	4/10	5/1	5/9	5/7	5/2	6/7	5/-	5/-	4/10	4/10
Poor Rate ..	3/-	2/10	2/10	3/-	4/-	4/-	4/2	4/1	4/4	4/7	4/8	4/10

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Vital Statistics.—The average birth and death rate per 1000 of population for 1911 and ten previous years are as follows:—

	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911
Total births ..	954	959	967	966	934	979	927	1035	985	940	904
Birth rate ..	31·7	31·0	30·6	29·8	28·2	28·8	26 6	29·0	26·9	*25·1	26·5
Total deaths ..	451	441	432	463	399	475	441	438	425	380	439
Death rate ..	15·0	14·3	14·0	13·3	12·0	13·9	12·6	12·2	11·6	*9·7	12·9

* Calculations made upon a larger estimated population than the Census figures produced.

FINANCIAL STATEMENT.

Borough Fund.

	Loans sanctioned.	Amount now owing.
	£	£
Town Hall	6,150	4,958
Lowestoft Burial Board	7,500	5,412
Tramways	84,230	68,933
	£97,880	£79,303

General District Fund.

	Loans sanctioned.	Amount owing.
	£	£
Sewerage Works	33,070	14,700
Street Improvements	85,241	39,547
Sanatorium	9,453	5,490
Sea Defence Works	78,013	26,683
Fire Brigade	621	244
Destructor	7,160	4,320
Public Walks and Pleasure Grounds	9,014	5,760
New store	240	132
Public conveniences	1,243	413
Lowestoft Burial Board	994	994
Electricity Undertaking	99,318	78,030
	£324,367	£176,313

Streets and Roads.—The total length of highways repairable by the Council in 1885 was 19 m. 7 fur. 4 pls., and the length of private streets and roads was 9 m. 0 fur. 6 pls., making a total mileage of streets and roads within the borough at that period of 28 m. 7 fur. 10 pls.

In 1911 the length of highways repairable by the Council had increased to 36 m. 5 fur. 18 pls., to which must be added 2 m. 7 fur. 32 pls. of backways from 9 to 15 feet wide. The length of private streets at this time was 4 m. 0 fur. 3 pls., giving a total mileage of streets and roads within the borough at the present time of 43 m. 5 fur. 13 pls. All the roads are

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macadamised with the exception of the tram track. The principal streets and roads are repaired with Guernsey granite and all other roads with broken flint. The curbing generally used is 12-inch by 3-inch tooled York or 10-inch by 6-inch granite on edge, the channels being paved with granite setts or scoria blocks 15 inches by 18 inches wide. A 10-ton steam roller by Aveling and Porter is used for consolidating the macadam roads, and has been in use since 1887. We have not done much in the matter of tarring the surface of roadways, but last year we did a length in Kirkley of about a mile containing 17,000 sup. yards, which came out at 0·87*d.* per yard. For this work the Author used one of Johnson's boilers (80 gals.) with Waithman's reservoir brooms. The Esplanade from Royal Plain to Claremont Pier, formerly in gravel, was reconstructed and improved in 1908 at a cost of 1467*l.*; this worked out at 3*s.* 1*d.* per yard. The channels were paved with concrete pamments, and the surface was laid with tarred furnace slag. Bottom formed with 1½-inch slag rolled to 2½ inches thick, and topped with a finished thickness of ¾ inch of ⅜-inch slag. There were no main roads in the borough when the Local Government Act was passed, but in the year 1889 the Town Council applied to the County Council to declare ten miles of roads within the borough to be main roads; this the County Council refused to do, and made a contribution of 300*l.* towards the cost of maintaining seven miles. This was increased in the year 1892 to 771*l.*, and again in the year 1906 to 985*l.*, and finally in the year 1908 the contribution was increased to 1200*l.* One of the first acts of the County Council of East Suffolk was to pass a resolution on November 7, 1889, "That no street in a town be accepted as a main road." This resolution has been acted upon ever since. The County Council determined, instead of declaring roads in towns to be main roads, to make a contribution towards the cost of such roads as would otherwise become main roads. The County Council thereby evaded the obligation to wholly maintain and repair such roads, the contribution under section 11 of the Local Government Act, 1888, being a voluntary payment. The County Council has, however, recently rescinded this resolution, and the Town Council has made application for about 10 miles of roads to be mained. Our total expenditure on streets and highways for the year ending September 29, 1911, was 5587*l.*; for scavenging, 1967*l.*; and for watering, 1083*l.* For the year ending

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September 29, 1886, the cost was as follows: highways, 2045*l.*; scavenging and refuse removal, 1581*l.*; watering, 366*l.*

Private Street Works.—All this work has been carried out under Section 150 of the Public Health Act, 1875. The total mileage of private streets made up from 1885 to 1911 amounts to 11 miles 4 furlongs 32 poles, at a total cost of 40,076*l.* This would give an average cost per yard run of the road of 1*l.* 19*s.* 10*d.* In 1885 and 1886 private streets were being made up under contract amounting to about 8936*l.* at an average cost of 2*l.* 10*s.* 4*d.* per yard run. All streets since that date have been carried out by direct labour at an average cost of 1*l.* 17*s.* 3*d.* per yard.

General specification for making up private streets used as ordinary residential streets:—

Carriage Way, 6 inches hard core, consisting of clinker of broken bricks, 4 inches broken flint, and 1 inch of binding, with 15-inch scoria sett channels.

Footpaths, 12-inch by 3-inch tooled York curb, 3-inch Portland cement concrete mixed six to one, and the top finished with sharp grit and cement in the proportion of one to one; 36-feet roads have carriageway 24 feet wide and 6-feet paths; 42-feet roads have carriageways 28 feet wide and 7-feet paths.

Sewers, 9-inch and 12-inch best stoneware pipes, jointed with cement.

Streets or roads subject to heavy traffic, such as Commercial Road, is made up as follows:—

Carriage Way, 9 inches hard core, 5 inches of 1¾ Guernsey granite, rolled down to 4 inches thick and 1-inch granite chippings for binding, and 18-inch granite sett channels on 3-inch concrete bed.

Footpaths, 10-inch by 5-inch granite curb on edge set on concrete bed, and concrete paths as before mentioned.

Commercial Road averages 42 feet wide, and the cost per foot frontage in this case was 15*s.* 1*d.*

Main Sewers.—The main intercepting sewer for the town north of the harbour with new sewer outfall into the sea was constructed about thirty years ago. The sewer was 4 feet diameter constructed in brick and concrete with blue Staffordshire brick invert. It extended from Rotterdam Road in the west, and ran in an easterly direction to the Battery Green, and from there was taken across the Denes and beach to valve-chamber.

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From this chamber were two rows of 36-inch cast-iron pipes carried on 12-inch by 12-inch timber piling into the sea, the invert of the pipes being about low-water level. The length of this sewer was 2223 yards and cost 7000*l*. The new outfall cost 5000*l*. The next large sewer, for the drainage of the St. Peter's Street district, was constructed in 1886, this being a 24-inch brick sewer connected with intercepting sewer near Old Nelson Street. The length of sewer was 934 yards, and cost 1700*l*. The drainage of the town south of the harbour occupied especial attention during 1885 and 1886, when what was known as the southern drainage scheme was carried out by Mr. Frank Stileman. This consisted of a 15-inch pipe sewer from Pakefield Street at the south boundary of the borough to a chamber on the south side of the harbour, syphoned under the harbour with two rows of 12-inch iron pipes to the ejector-chamber on the north side of the harbour, the sewage coming to this point by gravitation, and is then lifted by ejectors and carried by 12-inch iron pipes to the valve-chamber of main outfall sewer at the Ness Point. The entire cost of these works was 13,500*l*. The length of the sewer to ejector chamber is 2700 yards, and the length of iron rising main to valve-chamber 1333 yards.

The drainage of the Lorne Park District was carried out in 1894 at a cost of 860*l*.; length of 9-inch by 12-inch sewers laid, about one thousand eight hundred and ninety yards. In 1894 the Gun Lane District was re-sewered with 9-inch, 12-inch, 15-inch, and 18-inch pipes at a cost of 905*l*. Length, 1230 yards.

In 1904 the Beach District was redrained with pipes of 9 inches and 12 inches diameter, at a cost of 1364*l*. In 1904 new sewers in Denmark Road were laid, consisting of 9-inch, 12-inch, and 15-inch pipes, total length 1215 yards. Cost, 917*l*. A new 18-inch pipe sewer was laid in Whapload Road and carried north to a point near Model Yacht Pond for the drainage of the Gunton Cliff Estate; the length of this sewer was 1397 yards, and the cost, 1550*l*. Another 12-inch pipe sewer was laid in 1902 from the Ravine running north on Yarmouth Road, for the drainage of new estates in that district; length of sewer 515 yards. Cost, 1394*l*. In 1893, by the encroachment of the sea, we lost our outfall pipes and valve chamber at the Ness Point, which necessitated the diversion of the 4-feet main sewer round to the west of the gas works, with new valve chamber and outfall. This

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was placed 40 feet further north of the old outlet, and consisted of two rows of 36-inch diameter cast-iron pipes carried on cast-iron cradles with three rows of 10-inch cast-iron piles. These works cost 9292*l.*

Storm-water Relief Sewers.—A storm-water 12-inch relief sewer was constructed in 1898, at a cost of 163*l.*, to relieve the London Road South sewer at Parade Road South. A new 12-inch storm-water sewer was constructed in Pakefield Street in 1904: length, 440 yards; cost, 242*l.* The following storm-water relief sewers are in course of construction and nearly completed:—30-inch pipe sewer, 454 yards long, across Smith's Marsh to harbour, at a cost of 698*l.*, overflow direct off main intercepting sewer Rotterdam Road. 24-inch pipe sewer from Bevan Street to dock in place of a 15-inch pipe previously existing: length, 342 yards; cost, 325*l.* 24-inch pipe sewer across Battery Green to Herring Dock: length, 110 yards; cost, 180*l.*, overflow from main sewer. 24-inch pipe sewer from end of Pakefield Street to water-course: length, 182 yards; cost, 168*l.* (in place of an existing 9-inch pipe).

House Drainage.—A considerable amount of work has been carried out under this heading, in fact the bulk of the houses have been redrained. In 1886 we had about three thousand five hundred common privies and middens in the town. At the present time we have but few, and these are in the outlying parts of the town. Nearly all privies have been converted into W.C.'s with approved pans and proper flushing cisterns; middens done away with and replaced by galvanised iron bins for garbage. All house drains are constructed of 4-inch and 6-inch best stoneware socketed pipes jointed in cement, and when under buildings embedded in and covered over with 6 inches of Portland concrete, turning chambers built at all changes of direction, and all house drains are disconnected from sewer by intercepting trap in chamber, with 4-inch iron vent shafts fixed at summit levels.

Ventilation of Sewers.—Many years ago the sewers were ventilated at the street surface with open covers at all manholes and lampholes with a few shafts. These open gratings have been gradually closed, and vertical shafts substituted. The shafts consist of 6-inch by 4-inch and 9-inch by 6-inch cast-iron pipes with moulded caps and rust pits at foot of shafts, and are fixed in many cases on gable ends of houses where suitable positions could be found, and in other cases 6-inch and 8-inch steel shafts,

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25 feet to 23 feet high, have been erected. Total number of shafts erected about one hundred and thirty.

Street Improvements.—Many street improvements or road widenings have been carried out since 1886, as the main streets of Lowestoft were in many cases very narrow. High Street was improved by widening at the junction with London Road in 1888, at a cost of 10,400*l.* This dealt with about 480 feet of frontage, from 3 feet to 10 feet wide, the north part of High Street. This widening was carried out in 1897 at a cost of 13,300*l.* The houses were demolished, and from 12 to 20 feet were added to the width of the street for a length of 670 feet.

Clapham Road. The north end was widened in 1888, at a cost of 484*l.* This included the purchase and pulling down of a cottage and adding 196 sup. yards into the street; further improvement was made immediately south of this in 1888, throwing 6 feet into the roadway for a length of 300 feet.

St. Margaret's Road Improvement. Roadway widened on an average of about fifteen feet for a length of 1744 feet, at a cost of 918*l.*

Carlton Road Improvement, carried out in 1898 at a cost of 1198*l.*, widened on an average of 13 feet for a length of 907 feet.

North Parade Improvement, carried out in 1899. This consisted of widening the road, constructing retaining wall, paving concrete footway and curbing and channelling at a cost of 2900*l.* Further widening of the same road in 1900 cost 1034*l.*

Beccles Road Improvement, carried out in 1909 at a cost of 452*l.* This consisted of taking off about ten feet from allotments and adding to the roadway for a length of 1316 feet.

Under the Local Act of 1901 many other street widenings were carried out, during the construction of the tramways, at a cost of 24,073*l.*

Parks and Pleasure Grounds.—Belle Vue Park, at the north end of High Street abutting on the Yarmouth Road, was originally an open heath covered with gorse. This was enclosed, laid out, planted with shrubs and trees, and opened in 1874. At the foot of the cliffs is a fountain, the water of which has medicinal qualities. The ravine bridge from the Park to North Parade was presented to the town by the late Wm. Youngman, Esq., and opened in 1887. A meteorological station has been established in the Park. Sparrow's Nest, near the above, was purchased by the Corporation for a public pleasure ground in 1897, since which

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time it has been greatly enlarged and improved with bowling green and tennis courts. The Sparrow's Nest house was formerly the residence of Baron Alderson and his daughter, the late Marchioness of Salisbury. The North Denes were purchased from the Lord of the Manor in 1890 for the sum of 2570*l.*, containing about eighty-five acres, and additional land with the slopes were further acquired in 1891, containing 20 acres, at a cost of 750*l.*, and remains an open space and pleasure ground for the public; upon part of which was formed a model yacht pond which has been much appreciated by the public and visitors. Kirkley Recreation Ground, situate near London Road South, containing about seven and a half acres, was purchased by the Corporation in 1908 for the sum of 1600*l.* These grounds have been greatly improved, bowling green and tennis courts provided, and public conveniences and waiting-rooms erected by an additional expenditure of 650*l.*

Public Conveniences.—In 1893 a public underground lavatory and convenience was erected on Royal Plain, at a cost of 843*l.* The accommodation includes four-stall urinal, four W.C.'s, and five-basin lavatory for males. For females four W.C.'s and seven-basin lavatory, constructed of brick and concrete, and the inside walls faced with glazed bricks, the joiners' work of pitch pine. In 1907 an underground convenience for men only was erected on Blue Anchor Plain, High Street, at a cost of 193*l.*, accommodation five-stall urinal. In 1899 a public convenience was erected at road level near the Park, at a cost of 270*l.*; accommodation, five-stall urinal and two W.-C.'s for men; and three W.-C.'s for females; built in brickwork, lined inside with glazed bricks, and finished outside next street with half timber and rough cast. Besides the above we have several ordinary conveniences for men.

Town Depôt and Stables.—This establishment was started in a small way some thirty years ago, and there is now stabling for twenty-four horses, and shed accommodation for all carts and vans. All hay is cut and corn crushed on the premises by use of a gas engine. There has also of recent years been added painters' shop, carpenters' shop, and wheelwrights' and blacksmiths' shops for the purpose of carrying on Corporation work.

Refuse Removal and Destructor.—The house refuse removal has been carried out by contract for labour for the past twenty-five years, the present cost being 16*l.* 17*s.* 6*d.* per week. The contractor finds all labour, the Corporation supplying the necessary

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horses, carts, and plant. The refuse is collected daily in all the main streets and twice a week in other parts of the town, and carted to and dealt with at the destructor. In 1899 great difficulty was experienced in obtaining depôts for the deposit of nightsoil, and also for the sale thereof, and as the result, the Corporation decided to erect a destructor. A four-cell Horsfall destructor was erected on land known as Smith's Marsh on Rotterdam Road at a cost of 4709*l.* The furnace adopted is of the back feed type, with steam forced draft, grate area 30 feet per cell. Shaft 120 feet high. Babcock and Wilcox's boiler with Green's Economiser. The Corporation did not provide at the first to make full use of the steam, as we had no electric works at that time, and therefore only put in a boiler of half the proper capacity for full steam raising, it being intended only to provide steam for the blast and for driving the mortar mill, but preparation was made for a second boiler the same size, viz. 1619 square feet of heating surface. The economiser was provided large enough to serve two boilers.

For some time difficulty was experienced in getting rid of the old tins, etc., but they are now disposed of at the prices: old tins, 14*s.* per ton; old iron scrap, 8*s.* 6*d.* per ton; old enamelled iron, 5*s.* per ton.

In 1902 and 1907 an additional boiler and two additional up-to-date cells were added by the Horsfall Company for the sum of 2451*l.* We deal with about thirty-six tons refuse per day; some of the clinker is ground into mortar, for which we find a sale at 5*s.* per cube yard; the greater part of the clinker, however, we use ourselves in the making up of private streets, etc., as core; what is not required by the Corporation we sell at 9*d.* per load. The surplus steam is passed on to the electric light works, which are situated on the adjoining land, for which they pay 80*l.* per annum; and for the sale of mortar and clinkers we received last year 176*l.* The cost of collecting refuse is 2*s.* 3*d.* per ton and of burning 1*s.* 3*d.* per ton.

Gas and Water.—The supply of gas and water are in the hands of a private company known as the Lowestoft Water and Gas Company. The waterworks are at Lound, about five miles from Lowestoft, and the supply is derived from springs in the lake, and after filtration is pumped to Lowestoft, either direct into the mains or to a reservoir on St. Margaret's road. The charge to the Corporation for water is 1*s.* per 1000 gallons. The

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gasworks are on the Whapload Road at Lowestoft. Gas is charged to the private consumer at 3*s.* 10*d.* per thousand, less a rebate of 3*d.* per 1000 feet. The charge to the Corporation is 3*s.* per 1000 feet for power, and for the public lamps, of which we still have about 386 incandescent lamps, a charge of 50*s.* each per year is made; that is to say 1*l.* 10*s.* for gas and 1*l.* for lighting and maintenance, etc., the total cost for the year being 978*l.* All public lamps are now fitted with incandescent inverted burners.

Electric Lighting.—This is provided by the Corporation Electricity Supply, and is used throughout all our main streets, and at present there are:—83 arc and incandescent lamps; 26 16-c.p. lamps; 187 25-c.p. lamps; 127 32-c.p. lamps. The cost last year was 2266*l.*

Electricity Works.—These works were opened in February, 1901, and are situated at the junction of Norwich and Rotterdam Roads. The system of supply being continuous current on the three-wire system, giving a pressure to the consumers at 230 volts. The feeders are mostly paper insulated lead covered and double steel, taped, and laid direct in the ground. The distributing cables are for the main street on the solid system, that is laid in earthenware troughing and filled solid with bitumen. The public lighting cables are mostly laid direct in the ground. The service cables into the consumers' premises are also armoured and laid direct in the ground. The boiler house plant consists of the following, which is used both for the tramways department and the electric light department:—Two water-tube boilers capable of evaporating 5000 lbs. of steam per hour, fitted with chain grate stokers. Two water-tube boilers capable of evaporating 5000 lbs. of steam per hour, fitted with underfed stokers and superheaters. Dry back marine boiler capable of evaporating 10,000 lbs. of steam per hour with superheater. One water-tube boiler capable of evaporating 10,000 lbs. of steam per hour, with chain grate stokers and superheater. Three steam pumps for boiler feed. One electric pump for boiler feed. Six injectors for boiler feed.

Engine Room.—The generating sets were so arranged when the machinery was put in that any one set could be used for lighting or traction, the generators being compound wound with a switch on each machine to cut out the series winding if used for lighting.

The offices for the electricity department are in the same

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building as the tramways department and adjoin the engine room. Here all accounts are kept for both departments.

Statistics.—Number of units generated in one year, 1,408,237. Total number of consumers on the supply, 1446. Number of consumers connected in one year, 202. Total cost of construction, 95,349*l.* Amount repaid, 22,843*l.* Total receipts for one year, 16,244*l.*

Tramways.—The history of tramways for Lowestoft commences in August, 1898, when a letter was received by the Town Council from a firm of London engineers containing proposals for the construction of "The East Anglian Light Railways," which were to commence at Caistor, to the north of Great Yarmouth, and terminate at Southwold, passing of course through Lowestoft in the course of their route. In 1901, the Lowestoft Town Council obtained powers under the Lowestoft Corporation Act, 1901, for the construction and working of the present tramway system. Having found it impossible to carry out the terms of the agreement with the company, the Council decided to construct and work the tramway itself. Since then the Council has purchased the powers possessed by the Company for the construction of the line to Kessingland, so that in the future electric tramways, worked from the Lowestoft Corporation Works, may run from the Borough Boundary, Yarmouth Road, through the borough to Kessingland, a distance of 7¼ miles in all.

The System.—The system of traction is the overhead trolley, the line extending throughout the main street from the north boundary, Yarmouth Road, to the south boundary, Pakefield, from which point the extension is contemplated to Kessingland, a distance further south of about three and a half miles. The gradients are not severe at any place in the town, the route, except for the branch to the depôt, consisting of practically one long, straight street, 3¾ miles in length. The curves are few, the sharpest being at the junction of Denmark Road and Suffolk Road. Whilst the construction of the line was in hand various street improvements were carried out, some of which were compulsory to give the requisite space, but most of which were for the town improvement. The total route length is approximately 5½ miles, there being 3½ miles single track, 1½ mile double track, or the equivalent of 6½ miles of single track with loops for passing. One great obstacle to successful running is due to the main line being divided by the harbour and crossed by a

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swing bridge, making it almost impossible to run the cars to a time-table. Owing to the large amount of shipping, especially during the fishing season, a considerable amount of unavoidable delay may be caused. A serious difficulty was encountered in the construction of the undertaking by reason of the swing bridge across the harbour, situated almost exactly in the middle of the town. The whole of the work on and in the neighbourhood of the swing bridge has been especially designed, and has had to meet with the approval of the Board of Trade as well as of the Great Eastern Railway Company, who control the bridge and harbour. The special work applies to the permanent way and also to the electrical equipment. A shallow section of rail has been employed for the bridge track fixed to the ironwork of the bridge and electrically bonded thereto, and the greatest care has been taken to secure alignment of the bridge rails with the track on either side. In this connection a mechanical device is employed, interlocking with the hydraulic levers operating the bridge.

The maintenance of the electrical circuit is secured in the following manner: Six light steel standards are mounted on the bridge, and the current is carried by means of overhead wires with special ears. These are further supported by stay wires. With this form of construction no undue strain is put on the bridge. A device is employed on the overhead line at either end to connect the trolley wire with the special work when the bridge is closed. The overhead line on the bridge and the approaches is fed by a separate underground cable connected through a switch placed on the bridge and operating with the movement of the bridge. When the bridge is tilted before swinging, current is completely cut off in this section, and renewed on again closing the bridge. The rail circuit is maintained under the harbour by means of a cable. Some difficulty was experienced in arranging for the carrying of the feeder cables under the harbour, but this work was eventually taken in hand by the Corporation themselves. The cables are drawn into a steel pipe and are connected to a switch and testing-board on either side of the harbour.

Overhead Equipment.—A double trolley wire is employed of hard drawn copper (3/0 S.W.G., 0·372 of an inch in diameter). This wire weighs approximately 1260 lbs. per 1000 yards, and is supported 21 feet above the track on steel brackets and arm poles with ornamental cast-iron bases.

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Car Depôt and Electrical Works.—The car depôt joins the Electricity and Refuse Works in Rotterdam Road. The line to it branches off from the main line at the Railway Station in Denmark Road, and terminates at present at the depôt. Accommodation is provided for nineteen cars and a track sweeper. Nearly the whole of the track in the shed is supported on pillars, thus allowing any car to be examined and repaired from beneath. There are excellent facilities for repairs, carpenters, machine fitters, paint shops, and smithy being provided at the Car Depôt.

Feeder Cables.—The traction cables are drawn through stoneware ducts laid in the centre of the track. The cables are led to section pillars from which the overhead line is fed.

Permanent Way.—The track gauge is of 3 feet 6 inches, and is constructed as follows: The ground being excavated for a depth of 12 inches and a concrete bed of 6 inches placed under the rails except at the anchor joints, where the ground is excavated for a further depth of 12 inches. Anchors are placed every fifteen feet along the rail, the anchor consisting of, for the intermediate anchors about 15 inches of old inverted rails riveted to the flange of the rail, and for the anchor at the rail joint a piece of inverted rail two feet long is riveted on to the flange of the rail.

All joints are bonded with No. 4/0 S.W.G., and crossed-bonded every fifty feet. The section of rail used is of No. 3 British Standard Section, weighing 100 lbs. to the yard. The paving originally was basaltic lava, but this is now being replaced by Jarrah wood blocks in the centre portion of the town.

The offices of the tramway department are in the same building as the electricity department, and adjoin the electricity works. Here all accounts for both departments are kept.

Tramway Statistics.—Passengers carried in one year, 2,644,845; average miles run in one year, 334,473; total receipts for one year, 11,973*l.*; total cost of construction, 79,235*l.*; average daily receipts, summer months, 57*l.*; average daily receipts, winter months, 23*l.*

For this information, and also that referring to the electricity department, the Author is indebted to the Manager, Mr. G. A. Bruce, M.I.E.E.

Town Hall and Public Offices.—The original Town Hall was erected in 1857 by the late J. L. Clemence, Esq., architect, and

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in 1876 was considerably altered. It only contained at that time council chamber, surveyor's office, inspector's office, and caretaker's apartments. In 1899 High Street was widened, and plans were then prepared to provide for the following accommodation: Mayor's parlour, surveyor's offices, accountant's offices, rate collector's office, sanitary inspector's office, medical officer's room, enquiry office, committee room, lavatories, and stores; these plans were adopted, and the works carried out at a cost of 5124*l.*

In 1904 further additional offices were built to accommodate the town clerk and the education department, at a cost of 1000*l.*

Cemeteries.—Kirkley Cemetery on the London Road, South, established in 1879 with mortuary chapels and lodge. Cost, 3300*l.* Area, 5½ acres. It is now necessary we should acquire additional land for this cemetery. Lowestoft Cemetery, situate on the Beccles Road, established in 1886, containing about fifteen acres, with mortuary chapel and lodges, at a cost of 7500*l.* In 1906 3¾ acres of land was purchased by the Burial Board and added to the grounds; laid out and fenced in at a cost of 994*l.*

Isolation Hospital.—The old wooden infectious hospital stood on a small site near the Rotterdam Road, and in 1887 the Council considered the desirability of purchasing further land adjoining the same and to erect a new permanent Isolation Hospital. The Council eventually purchased about two and a half acres of land, and plans were prepared and approved for building administrative block, north-west pavilion for ten beds, and south-west pavilion for four beds, at a cost of 3373*l.* Then the laundry, ambulance shed, and disinfecting chamber, with fencing and entrance gates, were erected, costing 829*l.* In 1898 the south-east pavilion was added for eight beds, at a cost of 1414*l.*, and the administrative block was added to at a cost of 524*l.*, and in 1909 a new south pavilion was built for ten beds, and additional bedrooms, kitchen, etc., were added to the administrative block, costing in all 2278*l.*, bringing the total cost of the Isolation Hospital up to 8418*l.* All the buildings are constructed of brick with slated roofs, and the inside of all wards faced with glazed bricks, pitch pine floors and joinery, and the south ward floor is laid with Jarrah blocks on concrete and the floors are wax polished. All the old buildings were taken down and burnt.

Fire Brigade.—The brigade consists of twenty-three members: chief officer (honorary); superintendent, 10*l.* per annum; secretary, 5*l.* per annum; engineer, 13*l.* per annum; assistant engineer,

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8*l.* per annum; caretaker for each station, 6*l.* each per annum; superintendent No. 2 section, 5*l.* per annum.

Stations.—Chief Fire Station at St. Peter's Street. Sub Fire Station at Colville Road, Kirkley.

Appliances.—No. 1 Station: one 300-gallon horsed steamer; one 400-gallon horsed steamer; one manual; one hose cart; one hose reel; one 65-feet escape (hand) with shute.

No. 2 Station: one manual; one hose barrow; one hand curricle escape and hose box combined with shute.

Hose.—3000 feet at the two stations.

Average cost of brigade, 350*l.* per annum, which includes: salaries, horse hire, telephone rentals, hydrants, uniforms, hose, repairs to buildings, repairs to engines, etc., rates, taxes, and insurance.

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LOWESTOFT SEA DEFENCES.

By G. H. HAMBY, Assoc.M.Inst.C.E., *Member*,
Borough Engineer, Lowestoft.

The object of this paper is to give a brief description of the troubles experienced on this part of the coast during the last twenty-five years, and what the Corporation has done and expended to combat with this difficult question. Erosion has evidently being going on for many years; the beach consists of sand and shingle and a small amount of pebbles or larger stones, which twenty years ago were taken from the beach in large quantities, and, in the Author's opinion, was a great mistake. This was partially stopped some years ago, and is now stopped altogether. Lowestoft's coast-line is now far more exposed than in years gone by, when it was entirely protected by sandbanks, which were dry at low water, and the "Pakefield Gat" was further south. Now the outer banks, viz. the "Newcome," "Holm," and "Corton" sands, have two and three fathoms of water over them at low water, with the exception of a few small patches. The littoral drift on this coast is of sand and shingle, and travels from north to south, and doubtless the waste of the cliffs between Yarmouth and Corton has been forming the supply for Lowestoft. Jetties were constructed at the entrance to the harbour in 1832, and this caused the beach to extend seaward, as will be seen from the plan submitted showing the coast-line. The erosion of Lowestoft was more acute after the erection of the groynes at Corton in about 1871, which partially stopped the supply of beach material travelling in a southerly direction to Lowestoft. From 1894 to 1897 the sandhills covered with marrum grass, the only natural barrier protecting the Denes at that time from high tides, were greatly damaged, and during this period temporary measures alone were adopted for protection by faggots and placing two old smacks' hulls as groynes.

In 1897 twelve groynes were placed on the beach to the

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north of the Ness Point, formed of 4-inch planking; these at first were effective, and the beach accreted to the top of many of them, but for the want of something behind them more substantial than the low sandhills, the gales and high tides in 1898 swept round the land ends of the groynes and scoured the beach away; and in March 1901, during a severe north-east gale and heavy sea, the marrum hills protecting the Denes were almost entirely demolished, and the groynes became useless and were afterwards removed.

The old sewer outfall occupied a position at the Ness Point, with valve-chamber well above high-water line; these gradually became so severely damaged that the Corporation decided to abandon the old outfall and construct a new one. The old jetties carrying the outfall pipes were close piled on the north side, and, so long as they lasted, formed a groyne and held the beach up; but in 1895 these were all washed away, the Ness Point practically disappeared, the coast-line straightened, and the material went south to help the accretion north of the harbour.

Referring to the south beach. At the South Pier the beach sets back from the north side about four hundred and eighty yards. Going south from the pier the coast-line is low to Claremont Pier, when the cliffs gradually rise to the Borough boundary; they consist generally of sand. Sea erosion along the whole length of this part of the coast has been gradual and very considerable. In the gales of 1898 a great fall of the cliffs took place, and the old pathway leading from the foot of the cliffs to the top of Pakefield Street was swept away, and the beach was lowered some three or four feet; and later, in March 1901, heavy north-east gales and spring tides caused alarming damage to Kirkley cliffs. The Author has no doubt that the cause of the denudation of this beach has been principally caused by the supply of littoral drift being stopped, to a great extent, by the protective works erected at the north side of the harbour by the Great Eastern Railway Company. In July 1898, a contract, extending over a period of three years, was made with the Case Syndicate for the erection of 60 groynes on the south beach for 5000*l*. Towards the end of 1900, two years after commencement, the Council considered the accretion unsatisfactory, as, during a gale, several of the groynes washed out, and, in December 1900, 200 feet had been washed away and

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one groyne completely disappeared, with the result that this contract was terminated.

This brings the Author's remarks on both beaches to the same period when matters looked so serious that the Corporation could see they would have to expend a considerable sum of money, and decided to call in Mr. W. T. Douglass, M.Inst.C.E., with the result that, in 1901, an extensive scheme of protection for both north and south beaches was adopted in accordance with a report made by him. This work consisted of a spur groyne from the South Pier, 240 feet long, and another groyne of the same length at the south boundary. On the north beach a sea wall from the Ness Point to the north boundary, to be protected by four main groynes and sixteen intermediate groynes. These works were carried out in their entirety in 1902 and 1903. In 1902 four groynes were constructed, after the loss of the Case groynes, for the protection of the sea wall in front of Kirkley Slopes. Further considerable damage then took place to the cliffs between Rectory Road and Claremont Pier, and in 1903 a timber close-piled revetment was constructed from Rectory Road to Claremont Pier, the above-mentioned groynes were extended 50 feet, and three small intermediate ones constructed, and four new small ones added immediately south of Claremont Pier. In 1904 a spur groyne was added to the south of the Pakefield groyne, and also in the same year a spur was carried to the south of the Ness Point groyne, and also 100 feet extension was made to the spur groyne at the south pier. In 1905 a small spur was added on the south side of the groyne near the Empire Hotel. In 1904 a great scour took place in front of the Esplanade (north of the Claremont Pier), and, under the advice of Lieut. Williams, of Aldeborough, three acute-angle planked groynes were constructed as an experiment, running in a NNE. direction. In 1905 toe-piling and planking was constructed at the foot of the slopes between Claremont Pier and Rectory Road, to prevent the sea washing the slopes down. In 1905 and 1906 a timber revetment was constructed south of Pakefield groyne to prevent the erosion of the cliffs south of the borough boundary, and the revetment on the north side was extended northwards to the Grand Hotel wall. In 1910 a sea wall was constructed from the Ness Point southwards to Hamilton Road, a distance of 610 yards, protected by six timber groynes. The length of sea frontage on the north beach is

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2964 yards, and on the south beach 2033 yards, making a total frontage of 4997 yards, all of which is now protected.

From the borough boundary at the north to a point where accretion starts, opposite the south boundary of the gasworks, an average encroachment has taken place of 412 feet to H. W. O. T. and 427 feet to L. W. O. T., which represents a lost area of beach, between H. W. marks of 1884 to 1911, a period of twenty-seven years, of about sixty-two acres.

From the gasworks to the north pier extension an accretion has taken place of about six acres to H. W. mark and 9½ acres to L. W. mark; and high and low water have been driven back an average distance of 123 feet and 190 feet.

In the case of the beach on the south side of the harbour from the south pier to the Claremont Pier, the sea has encroached on an average of 130 feet at H. W. mark and 175 feet at L. W. mark since 1884, except a small portion next the south pier inside the spur groyne, where low water mark has been driven back about 150 feet. From the Claremont Pier to Pakefield, the encroachment of both high and low water marks since 1884 has been 180 feet and 230 feet. This gives for the entire length of sea front, from South Pier to Pakefield Street, a loss of beach between high water marks of 1884 and 1911 of about twenty-two acres.

The Author has pleasure in exhibiting drawings, some of which are reproduced herewith, of various sea defence works as carried out at Lowestoft, and the actual cost of the same.

	Cost.
Sea wall, North Beach	£11,200
Main groynes „	12,050
Small „ „	6,673
Spur groyne (at Ness Point groyne)	1,106
Sea Wall, path and apron to South Slopes (Rectory Road to Kensington Road)	11,826
Spur groyne (at South Pier)	3,400
Main groyne (Pakefield Street)	4,000
Smaller groynes in front of South Slopes wall	2,000
Timber revetment (from Claremont Pier to Rectory Road including four small groynes and extending four others ..	8,115
Spur groyne (to Pakefield groyne)	1,253
Acute angle groynes (South Beach)	650
Piling and planking foot of South Slopes	636
Pakefield Revetment	1,001
Grand Hotel Revetment	933
Sea Wall, steps and slipways (from Ness Point to Hamilton Road)	3,870

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	Cost.
Six groynes to protect same	£4,415
Revetment (opposite Esplanade)	696
„ (opposite Empire Hotel)	670
Map showing high water marks of 1836, 1844, 1884, and 1911.	

The total cost of our sea defence works since 1896 has been 79,000*l.*

After the completion of the sea wall north beach, and main and small groynes above referred to, a considerable scour occurred on the south or lee side of the groyne at the Ness Point, leaving the piling and sea wall exposed about eleven feet; and it was then that the spur to the south of this groyne was constructed with splendid results, the beach having lifted several feet, and driven back low water to the eastward of the new spur. Exactly the same conditions happened at Pakefield Street, and a similar accretion of beach followed the erection of the spur groyne in that locality. After the erection of the spur groyne at the south pier an increased amount of denudation of beach took place north of the Claremont Pier, and, for the purpose of securing the effects of this spur further southwards, this groyne was extended 100 feet with better results.

Since the completion of all the works, we certainly have experienced a more reliable position, as the beach has gradually accreted and no coast-line has been lost for several years, and the beaches are in a better condition than they have been for many years.

DISCUSSION.

Mr. Norman Scorgie: I have pleasure in proposing a hearty vote of thanks to Mr. Hamby. I am afraid I cannot congratulate Lowestoft on the lowness of its rates. A rate which aggregates 9*s.* 8*d.* in the pound cannot be considered low. I am quite prepared to admit that the works which have been carried out are most extensive and very expensive; it may, however, be possible to recoup these expenses by means of an increased rateable value. As regards your streets and roads, I do think you are suffering under a disability in your treatment by the County Council. I think they are treating you unfairly, and if you can only succeed in getting them to be reasonable in the matter, it would be advantageous to Lowestoft. Respecting

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your private street works, there is one point which I take exception to—that is the flagging of your footpaths with concrete. I can quite understand that at the moment it means a reduced assessment to persons who own the house property, but while you are saving the expenses of the frontagers, you are making expense to yourselves in the future. Probably you are getting your concrete footpaths done for 3*s.* 6*d.* to 4*s.* per square yard in the first instance; while when these footpaths are broken up for gas, electricity, or water mains, or for drains, the increased cost to the ratepayers is very considerable. If you would only pave the footpaths with slabs, which would probably cost you 1*s.* per yard more, the cost would be 1*s.* 6*d.* instead of 7*s.* in making good small openings in these footpaths, which originally cost 3*s.* 6*d.* Another point I want to call attention to, is that you are very leniently and economically charged by the Gas Company for public lighting. I find you are only charged 50*s.* per annum for incandescent lamps. I am taking it that each lamp consumes $3\frac{1}{4}$ cubic feet per hour, which with gas at 3*s.* 10*d.* per 1000 cubic feet works out at 46*s.* per annum, while the Gas Company are only charging 30*s.* for gas. Probably the decreased cost for public lighting is the reason for the very heavy cost of gas in this district. With regard to the character of the road adjoining the tramway, I do suggest that the gradients of the cross falls of the road are too much for the safety of the traffic. It was only in passing along your main street this morning on my way to the Town Hall that two unfortunate cyclists had side slips, due to the excessive cross falls between the tram rails and the footpath. Had that point been borne in mind when the tram rails were laid you would not have suffered the disability you have at the present time.

MR. E. J. ELFORD: I have great pleasure in seconding the vote of thanks to Mr. Hamby. I know how much labour is involved in the preparation of papers of this kind, and Mr. Hamby deserves our hearty thanks for the trouble he has taken. I do not altogether agree with Mr. Scorgie in his reference to the Lowestoft rates. Before expressing opinions of this kind we should know the basis of assessment, and whether the incidence of rating is high or low. There are many towns which appear to be heavily rated which really pay less per house than other towns which appear to have low rates. I have been much impressed by the economical way in which the work of the Borough

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is carried out, and I think, after taking into consideration the fact that Lowestoft has to bear heavy burdens, particularly for Sea Defence Works, which most other towns escape, the Corporation have done remarkably well. I agree with Mr. Scorgie to some extent as to the paving. I do not think the cost would be as much as 3*s.* 6*d.* to 4*s.* per yard; I should be surprised if it was. There is one matter with which I have a very warm fellow-feeling with Mr. Hamby, and that is with reference to the basalt lava paving of the tramways. I have had to take up a very large area of this kind of paving. I am rather surprised to see that the labour for the collection of house refuse is obtained by contract, the Corporation supplying the horses, carts, and plant. Under ordinary circumstances I think that the Corporation should have control of the men who have to collect the refuse, as these men have to go into people's houses, and be trusted to a very great extent, therefore the local authority should have direct control. Mr. Hamby has not stated what allowance is made for steam raised by burning the refuse from the electricity department. In regard to the collection and burning of refuse, I should like to ask whether the 1*s.* 3*d.* per ton for burning is the net cost after allowance for steam, etc.

Mr. J. W. Cockrill: I do not agree with Mr. Scorgie as to concrete footpaths. I do not think the footpaths here will cost 4*s.* per yard. Footpaths which were laid under my superintendence at Gorleston in 1874, are as good to-day as they were then. Those paths cost me 2*s.* 2*d.* per yard; to-day I am laying similar paths at 1*s.* 10*d.* per yard. If you lay footpaths which will last forty years at that price, I think they are the cheapest paths that can be laid. Whatever the cost has been, I think they will prove the cheapest for this district.

Mr. William Jones: The sea defence works at Colwyn Bay have cost my Council something like 70,000*l.*, but I have not had to undertake anything like the heavy coast work Mr. Hamby has. Your wave action and force of sea appear quite two hundred per cent. greater than at Colwyn Bay, and this shows the heavy responsibility which falls upon the Council of a town that happens to be placed on the sea coast where an incursion of the sea takes place. I am pleased with the protective measures which Mr. Hamby has carried out, and I am sure if left to himself, and not interfered with, he will be able to defend this coast from erosion. I was out very early this morning, and walked

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along the coast line of the borough, so have seen the expensive provisions which have been made to defend it. I am sorry Mr. Hamby has not given a little more figures and detail in his paper on sea defence, as undoubtedly the younger engineers would have been very pleased for the fuller information he could give on the matter.

MR. A. E. COLLINS: I know the serious difficulties Mr. Hamby has had to contend with in protecting this coast from the inroads of the sea. I know Mr. Hamby has his heart in that work, and I hope he will be successful. I, however, feel obliged to criticise one point in the paper dealing with sea-defence work. I may be wrong, but there appears to be one defect in the horizontally-inclined revetments.* The idea of the slope is all right, and the force of the waves is dissipated, but the groynes are not carried deep enough into the beach. Wherever you have a wave striking on to a surface at right angles you get a splash upward, and you get an excavating splash or action on the beach, which ought to be avoided by every possible means. The best way to avoid that is to carry the slope, which should be a flat one, below the surface, instead of having a vertical toe. I believe that any excavating action can be avoided in the manner I have indicated. I quite agree with Mr. Elford in his remarks as to the rates. I come from a city where the rateable value is very low, less than 4*l.* 10*s.* per head of population, but the people require as much to be done for them as in towns where the rateable value is double that amount. In Bournemouth the rateable value per head is double what it is here, so that they can spend twice as much money per head of population for the same rate. It is obvious, therefore, that it is unfair to make comparisons between different towns on the basis of rates in the £ only without considering the assessments. Having regard to the difficulties which confront Lowestoft, the rates are not high. I have used basalt lava for years, and a good many of the difficulties encountered with it are due to the manner in which it is used. There are places where no paving in existence will compete with

* Mr. Collins writes, subsequently—"*I thought the 'Williams' groynes' were what Mr. Hamby calls the 'revetments.' My remarks related entirely to these 'revetments.' I did not know of the existence of the Williams' acute-angled groynes; in fact, this description 'acute-angle' led me astray, as I thought it related to the vertical angle of the revetments, and not the horizontal angle made between water-line on coast and the groyne.*"

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basalt lava; that is where you have medium traffic and steep gradients. I have basalt lava which has been down, I think, fifteen or sixteen years, and is still in good order. But, in accepting deliveries, I throw out every stone which is a bit spongy. For heavy traffic it is no use, but with medium traffic it makes a good and suitable road for gradients too steep for granite.

MR. R. CROOME: I wish to ask Mr. Hamby why he uses Yorkshire kerb. The Yorkshire kerb which I have seen in the streets seems very much worn, and not at all a good kerb. I should have thought concrete kerb would have stood as well, and been much cheaper. The cost of collecting house refuse at 2*s.* 3*d.* per ton seems very low. The labour works out, allowing 200 tons per week, at 1*s.* 8½*d.* per ton, which only leaves 6½*d.* per ton for horses. Could Mr. Hamby tell me the cost of keeping horses. I am interested, because my Council propose to purchase horses at the present moment. Lowestoft is following the opposite practice to most towns, in contracting for labour, and owning horses. The usual course is to employ your own labour, and hire horses.

MR. T. W. A. HAYWARD: It appears to me that the heavy capital expenditure on the various undertakings owned by the Lowestoft Corporation has been incurred on the advice of, principally, outside engineers. The various schemes entrusted to Mr. Hamby, and which have been carried out so ably, have been done at a moderate cost, and, I am sure, we all congratulate Mr. Hamby on the good work he has done and the excellent results he is able to show.

MR. G. H. HAMBY, in reply, said: I sincerely thank you for the vote of thanks you have accorded me for the papers. Our concrete footpaths cost us about 2*s.* 6*d.* per yard super. The bulk of that has been put down in the third-rate streets or outlying thoroughfares, and the paths have not been broken up to the extent you would imagine. Some of these pavements, which have been down for twenty years, have cost very little for the purpose Mr. Scorgie referred to, and are not costing much today. Footpaths in the main streets have been laid in panels, four to the yard, and they cost us 7*d.* each at the present price of cement. This system has been adopted for all streets which are likely to be broken up or in any way disturbed for cable work. I should like to see them in all private streets, but I have only a certain number of moulds; they cost me about 10*s.*

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per pair, but the large amount of work which I have had to carry out has prevented me from manufacturing any large quantity. If I were to give you the number of private streets which have been made up and paved it would rather astound you. I quite agree with Mr. Scorgie as to the excessive gradient of the roads from the margin of the tram pavement to the channels. But it is not my fault; another engineer laid the tramways. I am pleased to say that I am now taking the opportunity of remedying that by lifting the kerbs, channels, and footways, and I hope in time the trouble will be overcome. Mr. Elford referred to the practice of contracting for labour. It has been the practice here for years to contract for labour; but the arrangements are in charge of an inspector, and no difficulty has been experienced at any time. I quite agree, however, that if a contractor is able to do the work for a certain price, the Corporation should also be able to do it. The contract comes to an end in October, and in all probability I shall then take over the work. In regard to the allowance for steam from the refuse destructor for the electricity work, it has been contended by our electrical friends that the destructor does not produce much steam; but that is not correct. We receive a payment of 80*l.* a year, the amount of steam produced is worth more than that, but the electricity works are only just turning the corner, otherwise the amount would be larger. With regard to Mr. Collins' remarks as to acute-angle groynes, they were put down as an experiment through the influence of certain members of the Council. My own opinion with regard to groyne work is that the structure should be put down somewhat at right angles to the foreshore. In reply to Mr. Croome's question as to why I use Yorkshire kerb, I may say that I get it as cheaply as anything. You have to recollect that at Lowestoft we have no quarries from which we can obtain stone to manufacture kerbs, and, as to making concrete kerbs, there is the difficulty of getting the necessary moulds and labour. In main streets I use 10-inch by 6-inch granite kerbs. In the private streets I can show you some Yorkshire kerbs which have been there twenty years and are as good now as ever. In reference to the remarks as to the rates, we have to take the rates as they are. I know the Council are very anxious to keep down the rates, and I can conscientiously say that everything I have done or carried out has been undertaken with the interest of the ratepayers in mind.

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The Members made visits of inspection in special cars to the Electric Works, Car-sheds, Destructor, Corporation Stables, and Isolation Hospital.

They were kindly entertained by the Mayor, T. E. Thirtle, Esq., to luncheon at the Royal Hotel.

Following the discussion on the papers, visits of inspection were made to the Sea Defence Works, Piers, Esplanade, and Parks.

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NORTH-EASTERN DISTRICT MEETING.

June 29, 1912.

Held in the Council Chamber, Town Hall, Bridlington.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE MAYOR (ALD. L. MAINPRIZE, J.P.) offered a very hearty welcome to the members of the Institution.

THE PRESIDENT thanked the Mayor for the kindly welcome he had extended to the members.

BRIDLINGTON AND SOME OF ITS MUNICIPAL WORKS AND UNDERTAKINGS.

BY ERNEST R. MATTHEWS, ASSOC.M.INST.C.E., F.R.S.(Edin.), *Member*, BOROUGH ENGINEER.

HISTORICAL.

BRIDLINGTON, although one of the oldest seaports in this country, is, nevertheless, one of its most popular health resorts. The town faces due east, and its sea front stretches along the shores of one of the finest bays to be found around our coasts, known as Bridlington Bay.

About five miles to the north of the town is Flamborough Head, that noble promontory which has provided shelter for so many mariners during northerly gales. Immediately to the north of Flamborough are Bempton and Speeton, where the cliffs rise in places to over 400 feet.

The quay existed as a port in Norman times, being mentioned in the Charter of King Stephen, confirming to the Priory the revenues of the harbour.

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Places of Interest in and near Bridlington.

Bridlington Priory.—The Augustinian Priory of Bridlington was founded by Walter de Gant, the Norman Lord of Bridlington, in the reign of Henry I. Its charter included the revenues of the harbour, which King Stephen confirmed, with the right to all wrecks on the Flamborough coast. It gradually acquired the rectories of the surrounding parishes, including Filey and Scarborough, and lands in almost every parish in this part of the East Riding. Its nearness to the coast rendering the Priory subject to descents of sea rovers, it was fortified in the fourteenth century. Of its defences there remains only the principal gateway, there having been originally three others. The church in its present form consists of a nave and side aisles with two western towers. Its dimensions are: Length, 185 feet; breadth, 78 feet; height, 70 feet. The original design appears to have been similar to that of Beverley Minster; and the dimensions not inferior.

The Bayle Gate.—The Priory entrance, known as the Bayle Gate, near the north end of St. John Street, spans the approach to the precincts of the church. It has two archways, the main and a small side postern, each with beautiful recessed mouldings. Over the main arch is a shield with the three B's, the Priory Arms. The tower is of three low storeys; the two lower pierced for archery, the upper having three small Early Perpendicular windows. Four buttresses, dividing the front of the tower into three parts, complete the feature of an extremely simple but exquisite architectural composition. The lower rooms of the tower, formerly the porter's lodge and manorial prison, became in later times the town kydcott or lock-up; and the upper chamber, which was the Prior's manorial court, became the meeting place of the lord's feoffees for the transaction of their business. The vista through the main archway towards the western façade and south side of the church is one of the most beautiful views of the kind in England.

Danes' Dyke.—This prehistoric wonder is a vast entrenchment, somewhat of the same kind as those which are found in various parts of the Yorkshire wolds. The many flint implements found here in experimental excavations prove that it is of an age earlier than that of the ancient Britons. Danes'

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Dyke can be easily reached by a short walk (about two miles) along the cliffs in a northerly direction from Bridlington.

Holderness Coast—Coast Erosion.—The coast line extending in a southerly direction from Bridlington to Spurn, about 35 miles in length, is known as the Holderness Coast of Yorkshire, and has been discussed more than any other portion of our coasts, for the average rate of erosion on this coast is about 11 feet per annum, and greater than found elsewhere. Many towns and villages which were previously located here have long since disappeared, the sites of some of them being now covered by several fathoms of water at high tide.

When giving evidence before the Royal Commission on Coast Erosion some time ago, the Author stated that he estimated that 1,904,194 tons of cliff were washed away annually from this coast, and that since the Roman invasion 115 square miles of land had disappeared between Flamborough Head and Spurn; also that the coast line at that time was about three miles further seaward than at present.*

As to the erosion, what is actually taking place is as follows. The boulder clay composing the Holderness cliffs consists of clay, sand, gravel, and larger stones; the pummelling action of a wave at the base of the cliff in a short time causes huge fissures to occur in the cliff—these in time open out, until a mass of the cliff falls on to the foreshore. The action of the sea on this is to disintegrate the mass, washing away the sand and fine gravel, and converting the clay into mud, which is also washed away. The larger stones and coarse gravel remain, and these are washed up to the foot of the cliff, affording in a small degree a sort of natural protection to the cliff. Some of the extensive sea defence works (designed by the Author) erected during the past few years will be described later. Other places of interest near Bridlington include—

Rudstone (about six miles from Bridlington).—In the churchyard of this village, near the north-east corner, is a wonderful monolith of great antiquity, standing some 25 feet high, and tapering gracefully to the summit; it is said to extend as far

* Further information on this subject will be found in "Erosion on the Holderness Coast of Yorkshire," by E. R. Matthews (Min.Proc.Inst.C.E., 1904–5). "Coast Erosion and Protection," by E. R. Matthews ("Engineering"). "Towns and Villages which have disappeared from the Yorkshire coast," by E. R. Matthews ("Contractors' Record," June 16, 1909).

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below ground as it rises above it. The church has a Norman tower, and is itself of great beauty.

Flamborough Caves and Rocks.—A great feature of Flamborough Head is its caves, which are approached by boat from the north landing; and its lighthouse near the south landing. Scores of conveyances (motor and horse) leave Bridlington daily during the season for Flamborough, the charges being: motor char-a-bancs 1*s.* 3*d.* return, horse char-a-bancs 1*s.* return.

Bempton, Speeton, and Burton Agnes.—These are interesting villages a few miles from Bridlington, and are well worthy of a visit. The two first-named are the home of the birds' eggs collecting industry.

Filey, Scarborough, and Beverley are also within easy reach of Bridlington.

Other places of interest in Bridlington include—the Royal Prince's Parade (owned by the Corporation), the new Spa and Gardens, the harbour, and the unsurpassed sands (the children's playground).

General Statistics.

The resident population of Bridlington is 15,000 (if the census had been taken a month later it would have been about 17,000, so many houses being locked up for the winter); the sleeping population during the height of the season being nearly or quite 60,000.

Borough incorporated, 1899. Rateable value (1912), 96,405*l.* Area of borough, 2751 acres.

Death rate (1911), 14·81. Birth rate (1911), 20·09.

The rainfall for 1911 was 26·44 inches. The average rainfall for the past five years, 26·55 inches. Hours of sunshine (1911), 1755.

Number of houses in the borough, 4018, of which only about 40 are empty. Number erected during the past 13 years, 1200.

Levels, between 24 and 200 feet above ordnance datum.

Rates.—District rate, 3*s.* 10*d.*; poor rate, including the county and educational rate, and borough rate (3*d.*), 2*s.* 6*d.*: total, 6*s.* 4*d.*

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Sewerage and Sewage Disposal.

Sewerage System.—Up to the year 1878 the drainage system of the district was most defective, several old brick culverts with flat bottoms and arched tops, and built in 4½-inch brickwork with open joints, forming the main sewers of the town. The outfalls were into the harbour and direct on to the north foreshore respectively. The matter came before the Local Board in the year named for their serious consideration, the result being that they instructed Messrs. Brierly and Holt, civil engineers, of Hull, to prepare a main drainage scheme. This they did, and the Local Government Board held an inquiry the same year and sanctioned it, the estimated cost being 11,000*l.* At that time there were in the district only 690 water-closets. This number has since increased to 3427. The percentage of water-closets to number of houses in 1880 was 33, in 1899 it was 60, to-day it is 80; water-closets have to be put into all new houses. Under this scheme the total length of sewers put in was about 6½ miles, including a 24-inch cast-iron pipe outfall. Several old existing pipe sewers were picked up in connection with the new system.

Between 1880 and 1899 the town developed very rapidly, the population increasing from 7760 to 12,482. During this period 12 miles of additional sewers were laid and connected up to the main drainage system; and a 12-inch cast-iron pipe outfall was also laid on the north foreshore at the extremity of the borough, and extending well below low water ordinary spring tides. To this outfall a number of sewers in that part of the town were connected.

In 1899 the Author was instructed to examine the sewers in the borough and report as to their efficiency; this he did, and presented a scheme for the remodelling of the system, which included the laying of over two miles of surface-water sewers, the construction of 3 feet by 4 feet 6 inches in place of 2 feet by 3 feet egg-shaped sewers (Fig. 1), and 2 feet 4 inches by 3 feet 6 inches egg-shaped sewers in place of 24-inch pipe sewers; also the enlargement of a number of other sewers, the construction of a new screen-chamber on the south side of the harbour, the reconstruction of the old screen-chamber, and the laying of a new 30-inch cast-iron flanged outfall sewer under the south pier and across the sands in a southerly direction to low-water mark of

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ordinary spring tides, discharging within a few feet of the old outfall sewer. The outer 615 feet of the outfall is carried by 12-inch by 12-inch piles (pitch pine) as shown by the drawings.

The scheme also included the putting in of a large number of additional manholes and lampholes, and the building of fourteen automatic flushing tanks, these discharging from 300 to 500 gallons each; twelve additional ventilating shafts were also erected.

The Local Government Board sanctioned this scheme in 1900, the contract was let forthwith, and the whole of the work has now been completed, the total cost being about 12,000*l.*

The re-drainage of the Hilderthorpe district was not included in this scheme, but the rapid development of that part of the borough during the past five years has recently necessitated the taking up of several of the sewers and substituting larger ones, and this work has just been completed at a cost of 650*l.* Thus the South Cliff Road 18-inch pipe sewer has been replaced by a 30-inch sewer of concrete tubes laid 4 feet deeper than the old sewer. The 15-inch pipe sewer in Pembroke Terrace roadway has been replaced by a 24-inch sewer of concrete tubes; these also are laid 4 feet deeper than the old sewer. A new 15-inch stoneware pipe sewer has also been laid in Horseforth Avenue. New manholes have been built in place of the old ones, and several additional manholes have been added. During the summer months the sewage is screened before being turned into the sea. It discharges at all states of the tide.

WATERWORKS.

The Bridlington waterworks were established in 1865 by the Bridlington and Quay Water Company, Ltd., and the works were purchased by the Corporation in 1899, the amount borrowed being 70,000*l.* Some important extensions and improvements, costing about 13,000*l.*, have recently been carried out, and in connection with these Mr. F. J. Bancroft, B.Sc., M.Inst.C.E., was engaged to advise the Committee. The new pumping station was designed by the Author (see Fig. 2), and may be briefly described as follows:—

The cost of these buildings was 2400*l.*, which works out at 4½*d.* per cubic foot.

Engine House.—Floor area, 54 feet by 28 feet = 1512 feet

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sup. Height, from upper floor level to underside of girders carrying overhead crane, 14 feet 3 inches; height to bottom of steel roof trusses, 21 feet 3 inches; height between bottom and top floors, 9 feet 6 inches.

Boiler House.—Floor area, 55 feet by 23 feet = 1265 feet sup. Height (to eaves), 17 feet.

Coal Shed.—Floor area, 42 feet by 20 feet 6 inches = 861 feet sup. Height (to eaves), 11 feet.

Workshop.—Floor area, 29 feet 6 inches by 20 feet = 590 feet sup. Height, 12 feet 6 inches.

The works have been properly drained into the Corporation sewer in Scarborough Road. For a fuller description of these buildings see "The Surveyor." *

The new machinery has been put in under the supervision of the Waterworks manager (Mr. Walter Gibson), who has devoted much care and attention to the overlooking of this important work. The new plant will be described in a paper to be read by Mr. Councillor S. Charlesworth (retired mechanical engineer), deputy-chairman of the Waterworks Committee and a member of the Works Sub-Committee. The Mayor (Mr. Alderman L. Mainprize, J.P.) is the chairman of this Committee.

Streets and Roads.

The length of roads maintained by the corporation is 33 miles. In the quay portion of the borough some of the streets are very wide, Queen Street being 85 feet in width, Prince Street 100 feet, and Promenade 60 feet.

Tar Macadam Roads.—There are several miles of tar macadam roads, and these consist of 2-inch Scotch granite mixed with boiling tar, and laid to a thickness of 4 inches upon a foundation of brick-bats; in some cases where the traffic is heavy the centre of the road has a thickness of 6 inches of tar macadam. A sprinkling of whinstone chips, and in some cases of fine sea gravel, is added while the road is being rolled.

Where there is light traffic, the top layer of tar macadam consists of 1½-inch stone. The Author has erected a furnace and tar mixing shed, where the materials are dried before mixing.

* "Notes on the Designing of Modern Waterworks Pumping Stations," by E. R. Matthews, April 23rd, 1909.

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Ordinary Macadam Roads.—The macadam roads of the town, for the most part, have a chalk foundation; and, where the thickness of metal in the road is not considerable, in severe frosts the expansion of the chalk causes the road to break up. Two-inch and 2½-inch whinstone, obtained from Messrs. Ord and Maddison, of Darlington, is used for the metalling of the roads.

Tar Surface Treatment.—A great many of the roads in the quay portion of the borough have their surfaces tarred, and this is found to be very beneficial in allaying the dust and lessening the noise caused by the traffic on such roads. The method adopted in tarring the roads is as follows:—

A gang of men, eight in number, first sweep the road surface, the tar (cold) is then applied to the road by hand with ordinary brushes. The work only proceeds when the weather is most favourable, hot, sunny days being selected for this. On top of the tar thus applied ½-inch screened whinstone chips are then spread, or ⅜-inch screened slag, and these are rolled in by a 10-ton steam roller, and the traffic is allowed on the road almost immediately. Tar surface treatment is only applied to roads that are in a good state of repair. The Corporation have recently asked the County Council to purchase for them a tar spraying machine.

Tar-paved Footpaths.—Most of the footpaths in the borough are tar-paved, the surface being re-tarred about once in every three years; the tar is applied by hand, limestone dust is spread on the surface, and is rolled in by a 15-cwt. hand roller.

Flagging.—In many of the streets the footpaths are paved with York-stone flags, and in a number of the principal business streets the Author has laid 2½-inch "Nonslip" artificial stone flags, which in his opinion are preferable to ordinary York-stone flags. Good examples of work of this kind may be seen in Prince Street, Bridge Street, Cross Street, and St. John Street. The cost of laying these flags is given later in a tabulated statement.

Asphalte Footpaths.—The asphalte footpaths consist of tarred limestone laid to a depth of 2 inches, and put on in two layers, coarse and fine, and upon the surface of the footpath Derbyshire spar is sprinkled.

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Street Widenings.

The Corporation have spent a very great deal during the past ten years in carrying out street widenings and improvements.

Cross Street Widening.—Cross Street was widened from 19 feet (building to building) to its present width of 50 feet, at a cost of 3650*l.* The road was covered with tar macadam, laid in the manner previously described; 12-inch by 7-inch granite kerb was laid, 10-inch by 5-inch York-stone channel, and the footpaths were flagged with 2½-inch "Nonslip" flags, and are 8 feet 6 inches and 9 feet in width respectively.

Bridge Street.—This street was widened in 1903 from 24 feet in its narrowest part to 50 feet in its narrowest part, at a cost of 8200*l.*—5084*l.* of which came back by the re-sale of the building sites. A mass concrete retaining wall was built on the east side of the street, and upon this the fronts of the houses and business premises on that side of the street are built. The road and footpath were constructed similar to Cross Street, and this is now the principal street connecting the Quay and Hilderthorpe portions of the borough.

St. John Street Widening (Fig. 3).—This is by far the most important street widening which the Corporation have undertaken, and has cost over 30,000*l.* It has been necessary in carrying out this work to pull down about 60 houses, including a public-house and a chapel. Most of the surplus land has been re-sold; new lavatories have been built at the north end of the street, and the present average width of the road is 52 feet, compared with about 20 feet previously. Eight-feet footpaths have been constructed on the east and west sides of the street. On the east side the footpath is flagged with "Nonslip" flags, and on the west it is covered with asphalte. The kerbing consists of 10-inch by 7-inch hard York-stone kerb, and the channel 10-inch by 5-inch York-stone. The road is metalled with 2-inch whinstone, laid to a depth of 6 inches on a good brick-bat foundation, which is 12 inches in thickness.

Corporation Horses and Carts.—The Highways department have nine horses, which are stabled at the Corporation depôt; the stables being described later. Three of these horses are used for gathering street sweepings; and are light horses, which are used in connection with the Fire Brigade when required.

The Highways department have to hire a good many horses,

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and the price paid per day for horse, cart, and man is 7*s.*, or if by mileage, carting metal to outside roads for example, the price is 8*d.* per ton per mile.

Cost of Materials.—(When by rail, includes delivery to Bridlington Station; or if by boat, delivered into Corporation carts.)

CARRIAGEWAYS.

	s.	*d.*	
2½-inch Whinstone ..	11	3	per ton
2-inch „ ..	11	6	„ „
1½-inch „ ..	11	9	„ „
Whinstone chips ..	7	1	„ „
Unbroken Whinstone	9	6	„ „
2-inch Scotch granite (by boat)	8	6	„ „

Tar painting and coating with Whinstone chips, 1½*d.* per sup. yard.
Tar macadam, 3*s.* per sup. yard.
Brick bats, 2*s.* per load and cartage.

FOOTWAYS.

Tar painting and coating with limestone dust or fine sea gravel, 1½*d.* sup. yard.
"Nonslip" flags, 6*s.* 2*d.* laid, or 5*s.* 6*d.* not laid.
2½-inch York flags the same as "Nonslip" flags.
Concrete in situ, 3*s.* 6*d.* per sup. yard
Asphalte, 1*s.* 6*d.* per sup. yard.
10-inch by 7-inch kerb, 3*s.* 3*d.* per yard laid.
10-inch by 5-inch channel, 2*s.* 5*d.* per yard laid.
Limestone dust, 9*s.* per ton.
Sea gravel for concrete, 3*s.* 9*d.* per ton at depôt.

Rates of Wages paid to Highways Workmen.—Road foremen (two), 29*s.* per week each. Stable foreman, 29*s.* per week. Road roller drivers, one at 28*s.*, one at 26*s.* per week. Mason, 8*d.* per hour. Road sweepers, 23*s.* per week, and 6*d.* per hour overtime. General labourers, 23*s.* per week, and 6*d.* per hour overtime. Cartmen, 23*s.* per week, and 6*d.* per hour overtime. Temporary men, 5½*d.* per hour. Number of hours worked per week, 55½ in summer, and 50 hours in winter. Stone breakers, 3*s.* per ton, whinstone; cobbles, 2*s.* 6*d.*

The average number of men employed in the Highways Department, 50.

PRIVATE STREETS.

Private streets are made up and taken over under the Private Street Works Act, 1892. About forty-five of such streets have been taken over by the Corporation since the Author's appointment. On the south side of the town many of the roads, it will be seen, are in a deplorable condition, and there is no doubt some of these will be taken over in the near future.

The method of constructing private streets (when being taken over) is the same as that already described in connection

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with the construction of St. John Street, except that the footpaths are all asphalted. The average cost of private street improvement works is 4*s.* 6*d.* per foot frontage. The work is carried out by direct labour. This may seem a very low figure, but in nearly every case the kerbing and channelling has already been put in.

Back Roads.—A number of back roads have also been taken over; these have been covered with tarred macadam on a good brick-bat foundation, and they drain on to a centre channel.

Sea Defence Works and Sea Front Improvement Works.

Bridlington has a frontage towards the sea of about two miles—one mile south of the harbour, and one mile to the north. The protection of the portion immediately to the south of the harbour has been carried out by private landowners, viz. Messrs. Whitaker Bros. Beyond this a sea wall has been erected by Mr. J. W. Pitt, but this sea defence is just outside of the borough.

On the north side of the harbour the Corporation have spent during the past forty years, in protecting the town against the inroads of the sea, and in carrying out sea front improvement works, over 100,000*l.*, an amount which is larger than the rateable value of the borough.

The works carried out by the Author include: The extension northwards and seawards of the Royal Prince's Parade, the construction of the Victoria Sea Defences, and of the southern portion of the Sewerby Sea Defences, and of the erection of seventeen groynes upon the foreshore (see Fig. 4). Space will not permit in this paper of a full description being given of these, so that if the members require any additional information on this subject they will find same upon reference to a paper read by the Author before the Institution of Civil Engineers, in 1904, on "Erosion on the Holderness Coast of Yorkshire," and one read by him before the Society of Engineers, in May 1905, on "The Parade Extension Works at Bridlington," also in a series of Articles on "Coast Erosion and Protection" appearing in "Engineering."

Royal Prince's Parade.—This is undoubtedly one of the most

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popular places of resort at Bridlington. The massive sea wall, with the promenade and gardens at the back of same, were constructed about forty years ago, and power was obtained for the Parade to be enclosed and a charge made for admission. Since that time, however, it has been so considerably improved and extended, that those who have not seen this popular promenade for twenty years would scarcely recognise it to-day. There is covered accommodation for nearly 6000 people; the Grand Pavilion at the north end of the Parade seats 2300. The Floral Pavilion, so named because of the delightful manner in which it has been florally decorated by the town's gardener (Mr. S. R. Crofts, A.R.H.S.), also enables visitors to bid defiance to the weather; this building seats about 1500 people. The Victoria Rooms, a small theatre at the south end of the Parade, seats about 800 people, and has recently been re-constructed throughout, re-decorated, and re-seated, at a cost of about 400*l.*

There are also several ornamental colonnades on the Parade which afford further shelter.

The floral clock upon the Parade is admired by many, and it keeps excellent time; and during the season of 1911 the floral crown designed by Mr. Crofts was a source of great interest. The Parade is frequently the scene of fêtes, galas and illuminations, and, being lighted throughout with electric arc lamps, makes an ideal evening lounge. The takings on the Parade for the year ending March 31, 1911, were 12,749*l.*; the number of tickets sold was 151,634, which does not include special tickets sold on gala nights. The profit was 3314*l.*, and the amount handed over in the relief of rates was 1750*l.*, which equals a rate of about 4½*d.* in the £; a 1*d.* rate producing 390*l.*

The lower promenade on the Parade has been re-asphalted throughout this spring at a cost of 233*l.* or 1*s.* 5*d.* per super yard for the asphalting, the cost of preparing the foundations not being included in this. The work has been executed, under the Author's supervision, by Messrs. Josiah Smart and Son, of Westminster; the specification being as follows: Total thickness of Derbyshire limestone asphalte, 2 inches; number of layers, two; size of spar sprinkling, ⅜ inch; size of stone in first layer of asphalte, 1 inch; in top layer, ⅜ inch.

The extension of the Royal Prince's Parade, which the members will no doubt inspect, and the construction of the Victoria Sea Defences immediately to the north of the Parade,

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were completed in July, 1906, and formally opened, together with the Grand Pavilion, by the Lord Mayor and Sheriffs of the City of London, in the presence of the Lord Mayors and Mayors of most of the cities and boroughs of Yorkshire.

New Sea Walls.—The new sea walls are faced with Bramley Fall rock-faced stone, to match the old Prince's Parade sea wall. They are built with a stepped face, which in the Author's opinion, is the best type of construction—he considers that where stone can be brought to the site at a fairly reasonable rate, that is the best form of sea wall to construct, as the first cost is the last. The old Prince's Parade wall, which was constructed, as previously stated, forty years ago, has not cost one penny in repairs, except for occasional pointing of the joints. Not only so, but the Author's experience teaches him that a wall with a smooth face, especially if it be a curved face, creates a very much greater scour at the base than a wall similar to those under consideration, as the stepped face breaks the force of the wave and lessens the scour at the base of the wall very materially. Walls built of concrete *in situ* the Author deprecates, as they are a constant source of expense. The Alexandra sea wall at Bridlington is of this construction, and is a continual expense, the face of the wall having to be frequently repaired; only this spring it has cost 80*l.* in repairs. The stone used in the new sea walls at Bridlington came from the Leeds district, the railway rate being 6*s.* 6*d.* per ton.

"Undoubtedly the most suitable stone to face a sea wall with is granite or basalt, especially where the foreshore is chiefly shingle, and H.W.O.S.T. rises several feet up the wall. The Author has known cases where a sea wall has been faced with concrete blocks, and the force with which the shingle upon the shore was hurled against the wall during a heavy sea completely tore out the outer half of one of the concrete blocks, and severely damaged several others." *

The cost of the improvements just named, that is, the Parade Extension Works, New Victoria Sea Defences, and the Grand Pavilion, was just over 40,000*l.*; the Grand Pavilion costing 12,000*l.*; this building was designed by Messrs. Mangnall and Littlewood, Architects, Manchester, and was the selected competitive design. The foundations, which were of concrete and reinforced concrete, were put in by the Author, and certain

* "Coast Erosion and Protection," by E. R. Matthews ("Engineering").

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improvements to the building, particularly the balcony, have since been made by him.

Adjoining the pavilion is a commodious café surmounted by a roof garden. These improvements and extensions were necessary owing to the increased popularity of the Parade.

The terraces at the back of the Low Sea Wall are paved with 2½-inch "Nonslip" stone flags on concrete; the steps leading from one terrace to the next are of granite; and those which are reached by the sea are of special construction. On the third terrace a large colonnade has been erected, which accommodates several hundreds of people, and this portion of the sea front, as you know, is open to the public.

Floral Pavilion.—This building was erected in 1903 from the design of Messrs. Mangnall and Littlewood, and has since been considerably improved by the Author. It is constructed of wood, iron and glass, with glazed folding shutters at the ends of same, and is a favourite resort with both visitors and residents alike. The cost of the building, including the bandstand, was about 4080*l.* The Property Committee are now considering the advisability of extending this building, as it is found that if it were double the present size it would not be too large.

Other recent improvements on the Parade include new lavatories for both sexes, and a number of lock-up shops, while the floral clock before referred to and the delightful flower beds, add to the charm of the place.

The charges for admission to the Parade are as follows: Day tickets, 6*d.*; week-end (Saturday to Monday), 1*s.* 3*d.*; Friday to Tuesday, 2*s.*; weekly, 2*s.* 6*d.*; fortnightly, 4*s.* 6*d.*; three weeks, 6*s.*; monthly, 7*s.* 6*d.*; season, 21*s.*; children, half-price. Bath chairs and perambulators are charged for, and there is an extra fee to pay on the evenings when galas, including fireworks displays, etc., are in progress.

Groynes.—These may be briefly described as follows:—

"The Author recommended that the timber groynes adopted should extend seaward, 300 feet from the sea walls, but this distance was reduced to 200 feet, on account of the inconvenience which the longer groynes would cause to persons driving along the sands, as low-water mark of ordinary tides is only 390 feet from the sea walls. The groynes are constructed of pitch-pine piles and planking. The piles, 9 inches by 9 inches,

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and 14 feet in length, are shod with 18-lb. wrought-iron pile shoes, and are driven 8 feet into the boulder clay in pairs, leaving a space of 4 inches between the piles. The pairs of piles are placed 7 feet 6 inches apart, centre to centre. Planking, 11 inches by 4 inches, is inserted in the spaces between the piles, the bottom plank being put down entirely into the clay. At every alternate set of piles a bearer is bolted on for the bottom plank to rest upon. At the intermediate sets of piles, the bottom plank is bolted to the piles, instead of resting on a bearer, the object being to save excavation around the piles as much as possible, so that their stability shall not be impaired. A cross piece is fixed at the top of the piles to prevent the latter from rising. The groynes are so arranged that a depth not exceeding two planks usually projects above the sand level. As the sand accumulates, which it does most rapidly when the wind is blowing off-shore, additional planks are inserted, and the groyne is raised without any trouble. The planks are so arranged that one plank spans two bays, and the next three bays; and they are inserted so as to break joint." * The first four (experimental) groynes cost 718*l.*, or 18*s.* per lineal foot, and the remaining thirteen at the rate of 12*s.* 3*d.* per lineal foot. This was, however, an exceptionally low tender.

Borough Sanatorium.

The Borough Sanatorium, designed by the Author, was erected in 1902 at a cost, including purchase of land, erection of buildings and boundary walling, drainage, oil engine, disinfector, road-making, furnishing, etc., of about 4900*l.*, or 272*l.* per bed. The site is an admirable one for a sanatorium, being about a mile out of the town, and in an elevated position. It is situated on the east side of Bempton Lane, and is from 131 feet to 168 feet above ordnance datum. The aspect of the site is south-westerly, and the sub-soil consists of gravel on clay overlying chalk. There is plenty of room for extension, as the adjoining 7-acre field on the east side is the property of the Corporation.

The buildings consist of scarlet-fever pavilion, ward pavilion,

* "Erosion on the Holderness Coast of Yorkshire," by E. R. Matthews (Min. Proc. Inst. of C.E., 1904).

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observation block, administration block, laundry and disinfecting block, engine-house, stables and carriage-house, mortuary, and caretaker's cottage.

The accommodation in both the scarlet-fever and ward pavilions is for eight beds, and in the observation block for two beds, or a total accommodation for eighteen beds. The buildings are in red brick with stone dressings. A proper system of drainage has been carried out, with inspection chambers at every deviation in line, and the drains connect into a 9-inch pipe sewer, which conveys the sewage and surface water into a septic tank. The water supply is from a well 8 feet diameter and 150 feet deep sunk into the chalk. The water is pumped up into an overhead tank, which is 7 feet by 7 feet by 3 feet 6 inches in depth, and contains just over 1000 gallons, or two days' supply for twenty-two persons, allowing 25 gallons per head per day.

The pumps are worked by one of Crossleys' 5-brake horse-power oil engines. From the tank the water flows by gravitation to the various blocks. The wards are heated by hot-air slow-combustion stoves placed in the centre of the wards. The laundry block is fitted up with wringing machines, stoneware wash troughs, steeping tanks, drying horses, ironing stove, ironing tables, and the usual requisite fittings.

A Thresh steam disinfector is provided in the disinfecting chamber. The present staff consists of a matron, two nurses, ward's maid, cook, porter, and laundress.

The Sanitary Committee have recently instructed the Author to prepare plans of a new ward block, an extension of the administration block, and the provision of private wards; these improvements he estimates will cost 1500*l*.

The Medical Officer of Health is also the superintendent of the borough sanatorium.

Sanitary Improvements generally.—Before leaving the reference to the sanitary improvements carried out in the borough during the past few years, the Author would not forget to draw your attention to the excellent work in this direction done by his colleagues, the present medical officer of health (Dr. A. K. Jarratt), the sanitary inspector (Mr. J. S. Grunwell), and their predecessors. Scores of houses have been re-drained, and hundreds of nuisances rectified under their able supervision, and we should not, as a town, have the present low death-rate,

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and the reputation of being a "health resort" in the truest sense of the word, had it not been for their unceasing labours.

Fire Station.

This was erected in 1901 at a cost of 473*l.*, and is a building 45 feet by 30 feet inside dimensions, and accommodates steam fire engine, manual engine, fire escape, hose-cart, etc.

Corporation Stables.

This building was erected in 1901, and extended in 1906, and affords accommodation for eighteen horses; the cost of the building, including extension, being 1026*l.*

Public Nurseries.

These are situated off Quay Road, and adjoining the Corporation Depôt, and cover an area of about 1½ acres. The buildings consist of five greenhouses and a large palm-house, with a great number of cold frames. It is interesting to know that during the past year (1911) no less than 100,000 plants were here propagated for use on the Royal Prince's Parade, in the various public gardens, and also for decorating purposes such as mayoral receptions.

The meteorological observations are here taken by Mr. Crofts, and reports are sent daily to various newspapers throughout the country.

Public Gardens.

Whenever an opportunity has occurred for obtaining land at a moderate rate for the purpose of beautifying the town by laying out public gardens, the Property Committee of this Corporation have been alert, and land has been purchased; the result being that during the past few years the Beaconsfield Gardens, South Cliff Gardens, Pembroke Gardens, Victoria Gardens, Windsor Crescent Gardens and Vernon Gardens, have been laid out and transformed by the skill of our able superintendent of public gardens, Mr. S. R. Crofts (to whom we are indebted to-day for the floral decorations in this building in which we are met), from barren wastes to places of beauty.

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In connection with the South Cliff Gardens four kiosks and a large colonnade have been erected, and in the Pembroke Gardens an ornamental shelter has been built.

Electricity Works.

An Electric Lighting Provisional Order was obtained in 1900. In 1902 it was resolved to proceed with the works. The late Mr. F. H. Medhurst, B.Sc., M.I.E.E., of Westminster, was appointed the consulting electrical engineer, and he prepared the scheme, the Author designing the buildings, the latter costing 5562*l.* The sanction of the Local Government Board was obtained to the borrowing of 26,481*l.*; this was received early in 1904. In 1906 an additional sum of 8138*l.* was borrowed, this being for the laying of additional cables, putting in of additional plant, meters, etc.

The charge for street lighting per annum is about 2504*l.*, all the public lighting being by electricity, a thing which occurs in few towns. For private consumption the charge is 5*d.* per unit up to 500 units per quarter; exceeding 500 and not exceeding 750, 4½*d.* per unit; exceeding 750 and not exceeding 1000, 4*d.* per unit; from 1000 to 1500 units per quarter, 3¾*d.*; above this, 3½*d.* For power and heating: not exceeding 250 units per quarter, 2*d.*; from 251 to 500 units per quarter, 1½*d.*; above 500 units per quarter, 1¼*d.* The demand for private lighting purposes, power, public lighting, etc., is equivalent to 34,582 8-candle-power lamps. There are now 565 consumers against 300 four years ago. For public lighting there are 54 arc lamps, and a number of metallic filament lamps. Capacity of plant, 750 kilowatts. Maximum load recorded in 1911, 470 kilowatts. Total connections to main, 1037 kilowatts.

From time to time since 1906 further extensions and improvements of the plant have been effected under the able supervision of the borough electrical engineer (Mr. A. J. Beckett), who has designed these.

Public Conveniences.

During the past few years several public conveniences have been erected within the borough, namely, those in South Cliff Road, Marine Drive, St. John Street, and the Beaconsfield lavatories on the sea front. One of these is illustrated in Fig. 6.

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There is nothing special about them apart from the fact that reinforced concrete was used largely in their construction.

Housing and Town Planning Schemes.

The Town Council are now considering a scheme for the erection of a number of workmen's dwellings in the old town portion of the borough. These are very much required, owing to the extensive demolition of properties in that part of the town during the past few years for street widening purposes.

A Town Planning scheme is also being considered by the Council, and it might be mentioned that the area which is to be included in this scheme comprises a large portion of the rural district in the vicinity of Bridlington.

Extension of Cemetery.

Application has recently been made to the Local Government Board for a loan of 500*l.*, for the purpose of extending the borough cemetery in a southerly direction. 1700 additional grave spaces will be available. The area proposed to be taken in is 1½ acres, and this work it is hoped will be completed in the autumn.

Trees.

There are in the streets of Bridlington 1017 trees. The varieties best suited for this exposed district are the Elm (*Ulmus campestris*), Plane (*Platanus acerifolia*), Service (*Pyrus sorbus*), Sycamore (*Acer pseuda platanus*), and the Mountain Ash (*Pyrus Americana*). Average cost of planting a tree, including purchase of same, excavating, cartage, etc., 5*s.* to 6*s.* Cost of perforated iron grate, when used, 5*s.* 3*d.*—this is placed level with the asphalt, and allows the rain and air to get down to the roots of the tree. The method we find most suitable is to purchase the trees as saplings, about 4 to 5 feet high, at about 30*s.* per hundred, and grow them in the nursery for five or six years, when they are ready for the streets. By this method they become thoroughly hardened to the district, and grow much more freely than when brought from a distant nursery and planted in the streets forthwith.

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Use of Reinforced Concrete.

This interesting material has been used by the Author very considerably in Bridlington, but chiefly in the construction of retaining walls, roofs (slabs and beams), foundations, and steps. Particulars of its use in several works are now given.

Beaconsfield Lavatories.

A brief description of the reinforced concrete work in connection with these new lavatories is as follows:—

"*Concrete.**—The concrete used was in the proportions of 1 : 2 : 3, namely, one part Portland cement capable of passing the standard tests, two parts clean sharp sand, and three parts sea gravel, capable of passing through a 1-inch ring.

Steel.—This had to be of British manufacture, and capable of withstanding a tensile stress of 60,000 lbs. per square inch. No reinforcement was allowed to come nearer than 1 inch to the face of the concrete.

Shuttering.—This was substantial, and, for the retaining walls, was formed chiefly out of 7-inch by 3-inch deals and 1½-inch boarding.

Dimensions of Retaining Walls.

Length	47 feet
Height above bottom of foundations	12 feet 6 inches
Width of foundations	4 feet
Thickness of foundations	7 inches
Thickness of walls	5 inches
Width of counterforts	2 feet 9 inches
Thickness of counterforts	7 inches

Dimensions of Reinforced Concrete Beams.

10 inches by 8 inches (longest clear span, 13 feet 6 inches)
Thickness of reinforced concrete slabs .. .. .. 5 inches"

Roof Covering.—This consisted of 1½ inch of Limmer asphalte, put on in two layers. The cost of the reinforced concrete work and Limmer asphalting was 293*l.* 2*s.* 5*d.*; the estimated cost of monolithic concrete walls and asphalting was 368*l.*; saving 20 per cent. "The forms were removed after they had been up four weeks. The roof is in every way watertight, and the

* "Reinforced Concrete Retaining Walls," by E. R. Matthews (Trans. Soc. of Engrs., August, 1910). "Concrete and Constructional Engineering."

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walls present a smooth and uniform face. The combined live and dead load allowed for was 2 cwt. per square foot. The period for which the L.G.B. granted the loan was twenty-seven years."

Marine Drive Lavatories and Shelter.

Retaining Walls.

Height of back retaining wall (average)	12 feet
Thickness .. .. to	7 inches (base), 4 inches (top)
Foundation slab ..	6 feet wide, 7 inches thick, and strengthened by an inverted reinforced concrete beam, 18 inches by 8 inches.
Buttresses ..	10 inches in thickness, and (average) 10 feet apart
Roof slab ..	4 inches in thickness supported by 12 inches by 8 inches reinforced concrete beams.

A retaining wall of less height and lighter section was built in front of the lavatories, but as this is of similar design to the back wall, the Author will not describe it.

Steps.—Two flights of steps, each 8 feet in width, were also constructed in this material. The work was carried out by the Trussed Concrete Steel Co. upon their Kahn system, and the length of loan obtained was thirty years.

St. John Street Lavatories.—The roof of these lavatories was constructed in this material, and consisted of a 4-inch slab; 6-inch by 4-inch lintels carrying the lantern lights.

Reinforced Concrete Fish-Stand.

This is a small but very interesting piece of reinforced concrete work, and is briefly described as follows:—

It consists of a cantilever platform, carried by reinforced concrete brackets, which are 5 inches in thickness, spaced at 6-foot 2-inch centres, and of four to one concrete. The platform varies from 4 to 8 inches in thickness, is 50 feet in length, and the over-all measurement as to width is 9 feet 6 inches. "The reinforcement consists of $\frac{1}{2}$-inch, $\frac{7}{16}$-inch, and $\frac{3}{4}$-inch rods, with special clips and stirrups, and the work was carried out by the Chain Concrete Syndicate of Leeds, their price being 114*l.* 12*s.* 6*d.*, but this did not include the excavation and the cost of the iron railings. The work was completed in December 1910, and a test load of 2 cwt. per square foot was applied." *

* "Reinforced Concrete Construction in Theory and Practice," by Prof. Hy. Adams and E. R. Matthews (Longmans).

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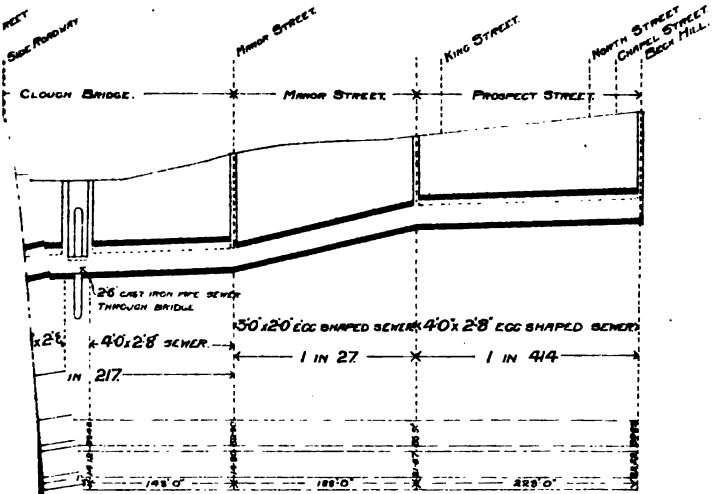

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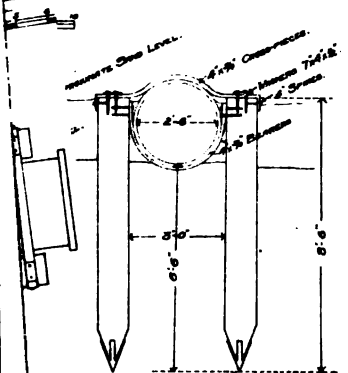

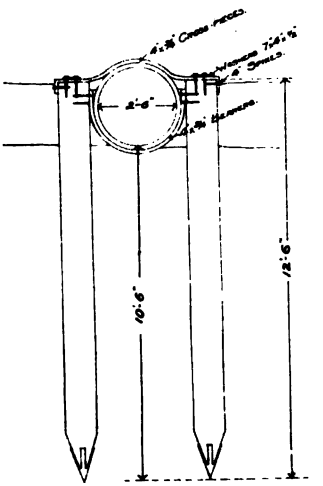

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The Author has recommended the Council to construct a continuous shelter on the sea front in this material.

Town Hall.

In conclusion, the Author would say, and he is sure that you will agree with him, that, having provided so admirably for the accommodation of the visitors, it is now quite time that the Corporation began to consider the desirability of providing for its own proper accommodation, and erecting a town hall worthy of this up-to-date and progressive borough. By so doing the officials would be able to discharge their duties with much less inconvenience than at present; and while the Author does not say that the work would be done any better, he does consider that it would be done more expeditiously.

However, this matter, he has no doubt, will receive their consideration at no very far distant date.

From the foregoing *résumé* of the sanitary and other works which have been carried out during recent years at Bridlington, the Author thinks that you will agree with him that the town council's policy has been a progressive one, and that they have moved with the times; and he is sure of this, that if they continue to do so there will be little fear of the popularity of this charming health resort waning. Dr. Johnson used to say, "The business of life is to go forward." The Author thinks it might be said that the Bridlington Town Council have realised the truth of that statement, and have tried to act up to it.

He hopes that the next time the Institution visit us we shall be able to show you our new town hall, workmen's dwellings, municipal common lodging house, and last, but not least, our refuse destructor.

He would like to acknowledge the valuable assistance of his Deputy, Mr. J. S. Hunt, and of his staff in the designing and carrying out of the various works referred to in this Paper.

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BRIDLINGTON WATERWORKS.

By Councillor SIDNEY CHARLESWORTH,
Deputy Chairman of the Waterworks Committee.

The first record of a public water supply in Bridlington refers to the discovery in 1811, of an ebbing and flowing spring in the harbour, at a depth of 43 feet, by Mr. Benjamin Milne, collector of customs. Mr. Milne had a reservoir made and a pump fixed at his own expense. This supply is still used by the shipping frequenting the port, and by the local fishermen. Some time after the work had been finished, Mr. Milne wrote to the lords feoffees (the lords of the manor) asking them to make him a grant towards the expense he had incurred for the public good, and he seems to have found them very unwilling to help him. In passing, the Author would like to mention that exactly a century ago, viz. 1812, John Rennie was consulted, and he reported on a new harbour for Bridlington. Copies of his report are occasionally to be met with in the town.

In 1865 a number of local gentlemen formed themselves into a Company under the title of The Bridlington and Quay Water Co., Ltd., with a capital of 20,000*l*. They supplied the town without obtaining an Act of Parliament for ten years; then they, with the assistance of the Urban District Council, obtained an Act with clauses facilitating the purchase of the undertaking by the Local Authority, and increasing the authorised capital to 40,000*l*. In 1899 the Waterworks undertaking was acquired by the Town Council, the amount paid for it being 70,000*l*. The loan period was fixed at fifty years, and the money was borrowed at $3\frac{1}{2}$ per cent. The cost of the arbitration, viz. 2000*l*., was shortly afterwards repaid out of the waterworks' revenue. The Author was elected on the Council on November 1, 1905. He immediately raised the question of the inefficiency of the pumping machinery to meet the needs of a growing town like Bridlington. On January 23, 1906, the Waterworks Committee were

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empowered to call in expert advice, and Mr. F. J. Bancroft, B.Sc., M.Inst.C.E., Waterworks Engineer, was asked to inspect and report.

In his report, Mr. Bancroft fully endorsed the Author's contention that the old plant was out of date, wasteful in coal consumption, and dangerously inadequate for the work required. He strongly recommended the immediate installation of a modern pumping engine in duplicate. This the Council decided to do, and prepared to apply to the Local Government Board for permission to borrow the money. It was then discovered that although the Bridlington Water Co.'s Act gave to the Council power to purchase the undertaking from the Company, and to borrow the money for that purpose, once it became their property, they had no power to raise loans for any further developments. It was necessary therefore to amend the Act, and this was done by a provisional order obtained in 1908.

The old works consisted of two stations, the upper and the lower. The latter was erected in 1865, at the junction of Long Lane and Marton Road, at a height of 100 feet above O.D. The area of the site is 1¼ acre; the works consist of engine and boiler house, fitting shop, manager's house, and office, and a disused reservoir. There is a well 6 feet in diameter and 100 feet deep. This station has been abandoned for purposes of obtaining a water supply, and the machinery has been broken up and sold.

Owing to the insufficient height of the lower station, the Company found they could not give a satisfactory supply, and in 1872, they erected a new station on the site of the present works. It was decided to use a set of wind-driven pumps, and a very substantial windmill tower with heavy head gear was erected. It was soon found, however, that this was not a reliable method, so another pump was obtained, and coupled in a very roundabout manner, to a steam engine, which had been designed for driving a saw-mill, and was supplied with steam from a Lancashire boiler. It was afterwards arranged to do away with the windmill, and couple both sets of pumps to the steam engine, which naturally involved further difficulties in gearing. As the engine had no steam-saving device, except a very inefficient feed-water heater, and was coupled to the pumps in a most complicated manner, it was found to be most wasteful in fuel.

The portions of the old works which have been retained are

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the well, the boiler-house (now used for storing coal), the engine-house, which will be converted into a storeroom and workshop, and the reservoir. The old engine and pumps have been broken up and sold, and the boiler converted into a soft-water feed-tank. This we find a most useful adjunct, as it allows soft water to be used for make-up instead of using hard well water. For several years it had been the custom to run both stations continuously night and day, seven days per week to supply the town during the height of the season. Any one conversant with water supply will realise the enormous risk we were running in so doing. It was most difficult, however, to convince some of the members of the Council and ratepayers of the absolute necessity for a new plant, but fortunately we were able to get the new machinery working from the deepened well before the record dry season of 1911 set in, otherwise the results to Bridlington as a health resort would have been disastrous. Owing to the fact that the new engines had to be fixed over the existing well, and that the lower station could not alone supply the town, the difficulty of installing the first set was considerably increased. The new boiler and engine-house having been erected, and the windmill tower pulled down, one half of the well curbing was removed along with one set of pumps and gearing; the remaining half being then securely strutted and braced to the new dividing wall. The delivery pipe from the remaining pump which had to be used was diverted, to allow the first set of foundations to be put in and its engine erected thereon. Mr. Gibson (our works manager) deserves credit for devising and carrying out this difficult piece of work.

The original specification prepared by Mr. Bancroft called for a duplicate steam-driven plant, capable of easily pumping 1000 gallons of water per minute at normal speed. Speed of pump not more than 120 feet per minute, and capable of working smoothly and regularly at half-speed, and also at thirty per cent. above normal. The engines to be designed to work most economically from a depth of 180 feet, and capable of pumping from a depth of 200 feet. The same conditions were specified for the suction gas and electricity tenders. The average of the tenders for steam and suction gas plants worked out at about 8500*l.* The tenders for the electrically driven plant averaged about 8000*l.* in each case, with travelling crane and all accessories.

The merits of the three systems were thoroughly discussed

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by the Waterworks Committee, and it was eventually decided to adopt a steam-driven plant, on account of its flexibility and reliability, especially when used for well-sinking and drifting, which had to be done with the new machinery as soon as it could be installed. The contract for the complete plant was placed with Messrs. Hathorn, Davey & Co., of Leeds, as follows, viz.:—Two complete compound horizontal differential surface-condensing pumping engines; cylinders 18 inches and 36 inches diameter respectively; each with two pump buckets 17⅛ inches diameter with a common stroke for engine and pumps of 4 feet. Two Cornish boilers, 6 feet diameter by 24 feet long, with a grate area of 18 square feet each, working pressure 100 lbs. per square inch. Two McPhail and Simpson superheaters, each with 350 square feet of heating surface. One Green's economiser, with 48 pipes. Small engine for driving scrapers. Two feed pumps. One 10-ton overhead travelling crane. The makers guaranteed that for each engine, with its boiler and accessories, when pumping at the rate of 1000 gallons per minute, against an average head of 180 feet, the amount of best Yorkshire screened steam coal used, having an evaporative capacity of not less than 9 lbs. of water per lb. of coal, from and at 210° F. with superheated steam at 100 lbs. boiler pressure, and a vacuum of not less than 27 inches, shall not exceed 186 lbs. per hour; and when pumping a similar quantity under the same conditions, against a total head of 160 feet, the fuel consumption shall not exceed 172 lbs. per hour.

Bridlington Waterworks.

Official Trials at Higher Pumping Station.

Contractors: Hathorn Davey & Co., Engineers, Ltd., Leeds. **Consulting Engineer to Corporation: F. J. Bancroft, B.Sc., M.I.C.E.**

Particulars of Trial.

		Engine No. 1.	Engine No. 2.
Date of trial		12/7/'11	13/7/'11
Duration of trial	hours	10	10
Steam gauge at engine	lbs. per sq. in.	95·3	94·4
Temperature at stop valve	° Fah.	399	428
Superheat at stop valve	° Fah.	65	94
Cut-off in H.P. cylinder		0·275	0·225
Cut-off in L.P. cylinder		0·4	0·4

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		Engine No. 1.	Engine No. 2.
Vacuum in condenser	inches	28·1	.. 028·75
Temperature in exhaust pipe ..	° Fah.	118	.. 116
Temperature corresponding to pressure in condenser	° Fah.	99·6	.. 86·1
Double strokes by counter in 10 hours ..		7793	.. 8314
Double strokes per minute		13	.. 13·85
Indicated horse-power of H.P. cylinder ..		33·95	.. 28·8
Indicated horse-power of L.P. cylinder ..		26·57	.. 35·75
Total indicated horse-power of engine ..		60·52	.. 64·55
Mean lift by well gauge	feet	167·7	.. 170
Mean discharge per minute by notch ..	gals.	1045·5	.. 1078·5
Pump horse-power in water lifted (actual)		53·13	.. 55·55
Efficiency $\frac{\text{Actual P.H.P. in water lifted}}{\text{I.H.P}}$	per cent.	87·8	.. 86
Boiler gauge..	lbs. sq. in.	103·7	.. 103·7
Temperature at economiser inlet ..	° Fah.	91	.. 82
Temperature at economiser outlet	° Fah.	166	.. 163·5
Temperature at superheater inlet	° Fah.	339	.. 338
Temperature at superheater outlet	° Fah.	453	.. 480
Air-pump discharge in 10 hours	lbs.		.. 13040
Temperature of discharge	° Fah.		.. 60
Jacket drains in 10 hours	lbs.		.. 774
Temperature of jacket drains ..	° Fah.		.. 188
Make-up feed	lbs.		.. 1784
Temperature of make-up feed ..	° Fah.		.. 67
Total feed supplied in 10 hours	lbs.	14380	.. 15,598
Mean temperature of feed	lbs.	72	.. 67
Drains from steam range	lbs.	40	.. 67·5
Feed-water supplied per hour	lbs.	1438	.. 1559·8
Coal used in 10 hours	lbs.	1800	.. 1908
Coal used per hour	lbs.	180	.. 190·8
Water evaporated per lb. of coal (actual) ..	lbs.	7·99	.. 8·17
Temperature of feed water ..	° Fah.	72	.. 67
Temperature of saturated steam at boiler pressure	° Fah.	340·1	.. 340·1
Temperature at superheater outlet	° Fah.	453	.. 480
Superheat at superheater outlet ..	° Fah.	113	.. 140
Thermal units required to convert 1 lb. of feed water into steam at boiler pressure and superheated as above		1199·9	.. 1217·87
Thermal units utilised from each lb. of coal (calorific value not known) ..		9587·2	.. 9949·9
Equivalent evaporation per lb. of coal from and at 212° Fah.		9·92	.. 10·3
Steam used per I.H.P. per hour	lbs.	23·76	.. 24
Steam used per P.H.P. per hour	lbs.	27	.. 28
Coal used per I.H.P. per hour	lbs.	2·97	.. 2·95
Coal used per P.H.P. per hour	lbs.	3·38	.. 3·43
Equivalent coal consumption per hour when pumping at the rate of 1000 gallons per minute against an average head of 160 feet	lbs.	167	.. 170·4

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This guarantee was fulfilled by both engines at the trial, and we have every reason to believe that the consumption under ordinary everyday working conditions has not greatly exceeded the guaranteed amount. The advantages of this type of engine are: long stroke, slow running, high combined mechanical efficiency of engine and pump, and, for the size of the engine, economical steam consumption. A further advantage is, the top of the well is comparatively clear for withdrawing the buckets and lifting heavy parts in the well. In order to avoid troubles due to high superheat, the steam from the heater is first taken through the low-pressure receiver, and thence round the high-pressure cylinder jacket before it enters the high-pressure steam-chest.

In running the plant, it has been found that the Baker's oil-separators work very much better with cold water jets fitted. The delivery mains discharge into a cast-iron tank, placed outside on the edge of the reservoir, with three V notches, and a chute discharging into the reservoir. A fixed scale with a movable pointer, gives a ready means of gauging the output of the engines at all times. This tank acts as a balancer when pumping direct into the town mains.

In addition to the main engines, there are two steam winches, with double oscillating cylinders and worm gearing, supplied by Messrs. S. A. Ward & Co., of Sheffield, and fitted with their patent reversing gear, a most interesting and simple method of steam distribution for this class of engine. Owing to a rather serious accident, which happened during the erection of the main engine, the Waterworks Committee decided that the hoisting engines, both for material and men, should be so arranged that there was no possibility of throwing the drums out of gear and allowing the weight at the end of the rope to be lowered by the brake only; hence the use of worm gearing on these winches.

As soon as both main engines were completed, and had worked long enough to see that all was in order, then the well sinking and adit driving was undertaken. The original depth of the well was 160 feet. This was lowered to 193 feet, and two adits were driven each being 50 feet long. The contract for this work was given to Messrs. B. Robinson and Son, Hull. The prices were 10 guineas per foot for sinking, and 2*l.* 14*s.* per foot for drifting. Brickwork in cement, including additional excavation, 3*l.* 15*s.* per cube foot. This work took four months

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to complete, working double shifts. The town had to be supplied with water partly from this well. The surplus water was discharged into the sewers in various parts of the town.

The L.G.B. have only allowed us fifteen years in which to repay our loan on the new pumping engines. One of the old engines (which was not specially designed for pumping) actually ran, and the boiler was in use, for over forty-five years. The cost of coal saved by putting in new engines is equal to the amount of principal we have to repay annually, the interest being paid out of revenue. The coal used by the new plant is one-third of that required by the old. Our water consumption works out at 43 gallons per head per day for all purposes; in the height of the summer season this is considerably increased. The metered supply is about ten per cent. of the total; the Gas Company supply, however, is not metered.

COPY OF ANALYST'S REPORT ON WATER FROM HIGHER WORKS.

Report on Water received from Bridlington Corporation, August 2, 1911.

Locality: Bridlington. Source: Well 192 feet deep. Soil or strata, depth and nature of: chalk.

Colour of water, two feet depth in Lovibond's units = 1·2 blue + 0·5 yellow. Smell at 100° Fahrenheit: faint earthy.

THE SAMPLE CONTAINS IN GRAINS PER GALLON (parts per 70,000):—

Chlorides equivalent to common salt, 3·23, containing chlorine, 1·97.
Nitrates equivalent to calcium nitrate, none, containing nitric acid, none.
Nitrites, none.
Phosphates, none.

Calcium, magnesium, carbonates, 15·57 } containing lead, none
Calcium sulphate, 1·60 } hardness, 15·2 °
hardness after boiling, 2·1 °

Volatile and organic matter (lost by careful ignition), 0·29 } containing ammonia, 0·006
containing alb. ammonia, 0·004
containing proteid ammonia, none
absorbing oxygen in 15 minutes, none
absorbing oxygen in 4 hours, 0·003

TOTAL DISSOLVED SOLIDS, 20·69

Sediment: very minute. Microscopic examination does not show the presence of animalculae.

Micro organisms per 1 cubic centimetre, examined by plate culture gives three colonies.

The colonies consisted of the bacillus Fluorescens liquefaciens, a non-pathogenic organism.

The chemical analysis and bacteriological examination show this to be a water of excellent quality for drinking and domestic use.

It is a hard water, but the hardness is not sufficient to render it objectionable.

THOMAS FAIRLEY,
City and County Analyst.

August 19, 1911.

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It will be seen that our water is very pure, but rather hard; this, however, can be overcome by boiling the water used for drinking, when the temporary hardness of 15·2 degrees is reduced to 2·1 degrees permanent hardness. Bridlington water after being boiled and then allowed to cool does not taste flat or insipid. Our water charges are 1*s.* in the £ on the rateable value; one W.-C., 10*s.*; extra W.-C.'s, 5*s.* each; bath, 5*s.*; water by meter, 1*s.* per 1000. It is the intention of the waterworks committee to reduce materially the charges on W.-C.'s and baths at the end of the present financial year. The income from the waterworks has increased by about twenty-five per cent. since the Corporation acquired the undertaking. Last year, the equivalent of a 2*d.* rate was handed over from the profits towards the reduction of the district rate.

When taking over an existing undertaking from a company by a small local authority, as was done in this case, a council might assume that the existing conditions and machinery were fully equal to the town's immediate future needs, and forget that the selling company have probably been trying to keep capital expenses down, and preparing for some years for a forced sale. The responsible officials and directors have always the demand of the shareholders for dividends to face; hence, they do not prepare so far ahead as municipal officials. It was for these reasons, that the Bridlington Council had to undertake the complete renewal of the machinery soon after it had been purchased from the water company.

DISCUSSION.

MR. FRANK MASSIE: To-day we are here to have the pleasure of showing our appreciation of the good work done by Bridlington in catering for the amusement and health of the great industrial centres of the West Riding of Yorkshire. One thing which has struck me very forcibly is the small number of empty houses. We who come from towns in the West Riding wish we could give a similarly small percentage. Forty empty houses, or 1 per cent., seems a very small number in a town like Bridlington. I remember not long ago being at an extension inquiry for a large city in Yorkshire where for nine days we pleaded to the authorities to bring forward a statement of

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the number of empty houses, but for obvious reasons it was not convenient to give that information. We can hope that some day those large centres of population will be able to show only 1 per cent. of houses to let in their districts. Evidently you have not overbuilt here. Probably when we go home we shall be able to persuade some builders to come and place their capital at Bridlington. Mr. Matthews says there are a number of private streets not in such a good condition as they should be. I do hope before our next visit the Corporation of Bridlington will have taken those streets into consideration and put them into good order. Nowadays we expect everything in seaside towns to look very smart, and the way in which private streets can be made up without any great increased cost, not in paving them with Yorkshire setts or granite setts, but still to make them attractive, is important to a town like this. Another matter I should like to ask Mr. Matthews about is the screening of the sewage before it enters the sea. I know this is somewhat of a delicate topic for a seaside resort, but if he thinks it would do any harm to the town he might tell me privately. The only other matter I wish to speak about on Mr. Matthews' paper is the Town Hall. This is a very nice room, bright and cheerful, but it is not very long since I had the pleasure of calling upon Mr. Matthews, and I was not equally struck with the accommodation provided in his department. No doubt this will be taken into consideration, and you will see that not only the rates are low, and the working classes are properly housed, but also that the officials have ample accommodation provided.

As regards Mr. Charlesworth's paper, it seems extremely good of a member of the Corporation to take the trouble to write a paper for our benefit. I think our thanks are due to Mr. Councillor Charlesworth for taking the pains he has done. I would suggest to the Mayor and Corporation of Bridlington that the additional water charges for water-closets and for baths should be crossed off as quickly as possible. How can you in a town like Bridlington, whose prosperity depends entirely upon its good name for perfect sanitation, cripple the provision of water-closets and baths by making an extra charge? Whilst glad to hear that it is the intention to reduce materially these charges, I would rather hear it is their intention to cut them off entirely. I have great pleasure in moving that our hearty

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thanks be given to Mr. Councillor Charlesworth and to Mr. Matthews for the two interesting papers.

MR. H. W. SMITH: It gives me very great pleasure to second the vote of thanks to our friend Mr. Matthews, and also to Mr. Charlesworth, for the papers they have so kindly put before us for our meeting this morning. I have looked through Mr. Matthews' paper, and find it full of interest. The small number of empty houses in Bridlington must be a matter of congratulation for the Mayor and Corporation, and, I have no doubt, the progressive spirit Bridlington has shown, backed up by the energy of Mr. Matthews, has a very great deal to do with that happy condition of things. I should like to congratulate Mr. Massie and Mr. Wakeford on their election to the important positions they now fill. If in a year or two Mr. Wakeford asks us in Scarborough if we are prepared to receive the Institution again I shall be very happy to do so. It is very gratifying to have a member of a Council putting a paper before us, and our thanks are specially due to Mr. Charlesworth in that respect. I have very great pleasure in seconding the vote of thanks to Mr. Matthews and Mr. Charlesworth for their papers.

MR. J. H. DREW: With reference to the ferro-concrete work, I think you have been very fortunate to get loans for periods of twenty-seven and thirty years from the Local Government Board. I am interested in a sewage disposal scheme in which we had to elevate the filters, the floors being designed to carry a superload of 6½ cwts. to the foot. Unfortunately we could not get more than a ten years' loan, despite much correspondence with the L.G.B. and reference to longer loans which had been sanctioned. The L.G.B. now state that ten years is the usual sanction for works in ferro-concrete. I took the matter up with our Institution to see if they could not bring pressure to bear with the L.G.B. to grant loans on ferro-concrete for a longer period. If a scheme will not last longer than ten years, they should "scrap" it altogether and not grant a loan at all. With respect to tar, do you use the local Gas Company's crude tar or some special preparation for tar spraying and making tar macadam, and what do you pay for it?

COUNCILLOR S. DYER, Bridlington: I have had the pleasure of being a member of this Institution since 1883 or 1884. Years ago I was able to attend the meetings more or less regularly, but in recent years it has not been possible to attend many

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meetings, but my interest has never flagged, and it has been a great pride and pleasure to go through the volumes of Proceedings year by year. I rose simply to say a word or two with reference to the housing of the working classes. We have during recent years demolished a large number of houses of a small type, but to-day these are the one great need of the district. It is not the large house that is required, but the very small one, and I am afraid it is a house which is not a paying concern. During recent months the Council have had under consideration the matter of providing a number of small houses for the working classes of this district. The great bone of contention has been the matter of site. The Committee over which I had the pleasure of presiding advertised for sites, and we had a large number offered to us. The Committee felt that one particular site was more suitable than the others, but, unfortunately, that did not meet the ideas of the Council, and when we came before the Council we were thrown on our beam ends by an adverse vote, the numbers being equal, so the matter was thrown back on the Committee. Recently the matter came before the Council, and we got it through, and we are hoping in a short time to make a beginning with the erection of some dwellings in which our workmen will reside. The plans are being prepared by Mr. Matthews, and I am sure he will be very glad for you to examine and criticise any part in connection with those plans. But you must remember that the great thing has been to provide a substantial kind of building at a minimum cost. They are not of an elaborate character, and while the specification is one which will bear examination, it is a material which will last, and there is nothing of a superfluous nature, or to make it of the villa style. We are now advertising for tenders for the erection of these houses, and when those tenders come in it is the intention of the Council to apply to the Local Government Board for a loan. The surveyor's estimate for the houses varies from 178*l.* to 207*l.* We are glad indeed to have a gentleman like Mr. Matthews as the surveyor. I know something of a surveyor's duties, because I was for a number of years surveyor here in Bridlington, and I know something of the anxieties which fall upon the shoulders of gentlemen who hold the position of engineer to a borough council. Only some people realise what that load means, but I am always delighted to feel that there is a brotherliness among the engineers

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of the various authorites, and if we do not happen to have experience in one particular matter we are able to appeal to others who have had experience, and thus help one another in that way.

MR. E. J. SILCOCK: I have some knowledge of Bridlington as a pleasure resort, and I have also the advantage of knowing something of it from the business point of view, so I claim a special interest in Bridlington. I am delighted to see the houses so fully occupied, and to hear that the rates are kept so low. I really must congratulate the Town Council upon having produced such excellent results without placing any undue burden upon the inhabitants. The two things, no doubt, react one upon the other: the fact that the houses are occupied causes the rates to be low, and the lowness of the rates causes people to come here. I was struck by the favourable contrast here with the number of signs of vacant houses in another watering-place—not a sea-coast town—which I had the pleasure of visiting a short time ago. The sewerage arrangements here are, I think, of a favourable character, due largely to the fact that the town is situate upon rising ground. That is a very great advantage to seaside places, and it is an advantage which all towns do not possess. There are many places, like Southport and other towns on the flat coast of Lancashire, where the houses are situate little above high-water level of the sea, with the consequence that they have difficulties with their drainage, and have either to pump or store their sewage, and in some places have to provide some kind of treatment before discharge into the sea. Here, owing to the greater elevation of the town above the sea, it is possible to discharge by gravity at any state of the tide. The prosperity of a place like Bridlington is so bound up with good sanitation that if there is any fear that the foreshore should be fouled it would have a most disastrous effect upon the town. It does seem to me, without being at all an alarmist, that this is a matter which the Corporation and its officials must very carefully watch to see if there is any tendency to pollution as the town grows, and if any ill effect is seen, to deal with it at once before it becomes noticeable by the general public. As to the sea wall and foreshore protection works, I think the excellence of these works is testified by the fact that they have stood the test of time, and the ravages of the sea, without showing any signs of deterioration. There are

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at Bridlington some sea defence works which were not carried out by the Council which have not been altogether so successful, but I think, so far as the works carried out by the Corporation are concerned, they have stood most effectively. This applies not only to the sea wall but to the groynes on the foreshore. The fine stretch of beach is an excellent playground for children, and one of the chief assets of the town, and therefore it is most important that it should be retained at a good level above low water. As to the design of the sea walls, I quite agree with the view expressed by the Author that the step-faced wall is better than the smooth face, whether that face be curved or straight. In my view the stepped face is less liable to damage through action of the receding waves than a flat-face wall. Then I notice, too, that the walls have been very successful in avoiding throwing the advancing waves over the back of the wall. Some walls which are curved have a nasty way of drenching people with water when they walk along the parade, which is very objectionable, besides being a danger to the wall. As to the waterworks, one cannot help realising that when purchased by the Corporation they were not in an altogether satisfactory condition, and the Corporation are doing nothing more than their obvious duty in renovating the works by putting in new machinery. They seem to have been successful in doing that, and, judging by the results of the official trial, the machinery seems to be highly efficient and of excellent design. It would be very interesting if the Author would add some information with regard to the purchase from the company. If he could tell us what the maintainable revenue of the company was before the Corporation purchased and whether the amount of compensation paid included any extra payment for back dividends or over-spent capital, or anything of that kind. If we had those figures before us it would be of value. Some reference has been made to the charge for baths and W.-C.'s, and I agree it is most desirable those charges should be reduced or withdrawn altogether, but one cannot help seeing that the Corporation have been most successful from the financial point of view in their management of these works, because to be able to carry on the waterworks for a charge of only 5 per cent. on the rateable value, and to hand over to the relief of the rates a sum equivalent to 2*d.* in the £ shows that the works are well constructed and economically conducted. Although those

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additional charges are put on for the particular services named, still the total charge to the ratepayer is not a high one, and it must be borne in mind that a very great number of houses in Bridlington are let for apartments and boarding-houses and that the water is used by the floating population as well as the resident population.

DR. H. T. CALVERT: Perhaps I may be allowed to raise one question about the water supply. This water supply appears to be derived from a well in the chalk and is rather hard. I would like to inquire whether the Corporation have taken into consideration the question of softening this water. Each degree of hardness corresponds roughly to a saving of soap of about 1 lb. per 1000 gallons. The present figure of hardness is about 15 degrees, which could be reduced to 2 by treatment with lime. That would mean a considerable saving in soap to the population. The soap bill must be a considerable item in every household when you take into consideration that the average amount of soap used per person is 40 lbs. In Russia it only amounts to about 2 lbs. per head of population. I should like to inquire whether any difficulties have arisen from growth or corrosion in the pipes. That is a matter which is now receiving more consideration than it did. A few years ago everything was lumped under the head of corrosion. Recently it has been shown that what has been called corrosion is due to growths in the pipes, or filters, or reservoirs. I should like to ask Mr. Charlesworth whether any difficulties have arisen, or are likely to arise from this water.

MR. J. P. WAKEFORD: I should like to thank Mr. Matthews and Mr. Charlesworth for their very interesting and instructive papers; they are both *multum in parvo*, and contain an enormous amount of information. I congratulate Mr. Matthews on being the engineer to an authority who are able to keep their rates at 6*s.* 4*d.* in the pound. First, with regard to private street works, I should like to know whether the streets are 36 feet wide, and whether the 4*s.* 6*d.* per foot run of frontage includes any proportion of the cost of sewers; also whether any change is made for supervision under the Private Streets Works Act. With regard to these automatic flushing tanks for sewers I should like Mr. Matthews to say whether he finds them satisfactory. My experience has been that they are most unreliable in their action, and I have never found them fulfil the conditions claimed for

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them. As regards lampholes on the sewers I have long abandoned them in favour of manholes, and I believe the Local Government Board now require lampholes to be discontinued. I should like to ask Mr. Matthews whether he finds the application of cold tar to the roads is satisfactory. There is no doubt that the tar treatment prolongs the life of the road to a considerable extent; but my experience of tar macadam is that it is only satisfactory so long as the traffic is not excessive. I agree with Mr. Matthews that the appearance of artificial flags is better than natural stone flags, and I would be inclined to adopt them if assured that they would not be disturbed; but in a manufacturing town the flags are constantly being disturbed for gas, water, and electricity mains, and if they are artificial, a great many are broken. As to the consumption of water, the use of 43 gallons per head per day strikes me as being very excessive, seeing that there do not appear to be any large manufactories or trades in the town. We are not told whether the Deacon meters are in use, but I cannot help thinking that a great deal of the consumption is avoidable. I have had experience of the Deacon meters, and find by their use one can effect a saving up to 40 per cent. I think the municipal work effected by Mr. Matthews must have something to do with the low death rate; and I congratulate both him and Councillor Charlesworth on their excellent papers, and on the discussion which they have elicited.

Mr. John F. Smillie: With regard to streets and roads, I was struck by the extremely low figure at which the streets are constructed—4*s.* 6*d.* per lineal foot of frontage. Bridlington goes in largely for tarred footpaths, which have to be retarred every three years; although constructed at the low figure of 1*s.* 5*d.* per yard, it strikes me if that cost has to be incurred every three years it becomes ultimately a very expensive form of footpath. I prefer a concrete footpath laid *in situ* or in panels, which I can lay at a cost of 3*s.* 4*d.* per square yard. There is a twenty to twenty-five years' life in such paths in residential districts. With regard to the application of tar to macadam roads, I should like to know if Mr. Matthews finds the application of cold tar quite successful. I have tried both cold and hot tar, and have not found cold tar a success; but the hot tar applied to a dry road has prolonged the life of the road considerably. I have not found tar used alone to be completely successful, and I invariably mix a little pitch with the tar. In

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the summer the ordinary tar from the gasworks becomes very soft, and something of a nuisance to people who wear light footwear and light dresses. I am using 25 to 30 lbs. of pitch to 40 gallons of tar. I find the quality of the tar that comes from the gasworks varies very much, and some dependence has to be placed upon the intelligence and judgment of the men who have the work to carry out. With regard to the sea defence works, I must compliment the Corporation upon the successful appearance those works present. I notice that some of the works have stood for forty years. Mr. Matthews refers to the contour of the wall. I have had some experience of sea defence works, for we have recently constructed a sloping wall in concrete blocks. The object in using such blocks was to provide work for the unemployed. We got a machine and cast the blocks on the ground. They are cast hollow, and we lace the blocks together with wire rope passed through the cavities, and afterwards the cavities are filled with concrete, so practically the face is a monolith. It has now stood for two winters without any sign of wear. While the terrace level is 12 feet above high-water mark sometimes the sea runs up the wall, and is thrown off by the coping. The parapet rail—both standards and rails—is constructed in reinforced concrete. The upkeep of these railings in iron or steel is a matter which requires constant attention. Although, as I have said, the rails are of reinforced concrete, it is noticeable by none but experts that they are in any way different from iron and steel; but, unlike iron or steel, they stand year after year without any cost for upkeep. With reference to the cement concrete blocks, although we have a lot of shingle on the beach, I have not found the blocks are in any way deteriorated by the action of the shingle on the face of the wall, and I venture to think it is going to be a work which will not concern me again whatever it may do for those who come after me. If sea defence work lasts thirty or forty years, it must be regarded as satisfactory. I was interested in what was said as to your housing and town-planning scheme, but I am afraid of treading on controversial ground. Mr. Matthews is hampered by the amount of money he has to spend on these houses; though I think they are capital productions for the money. The question is an economic one. Workmen's houses will never be entirely satisfactory until workmen are in a position to pay a proper rent for the houses they occupy. I would not like to be a party to constructing houses

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in which the living-room is 13 feet by 12 feet for a man and wife and three children, and in which the food has to be cooked. It is not houses of this class which are going to solve the problem of the housing of the working classes. We are much indebted to Mr. Charlesworth; it is gratifying that there is a member of the Council who takes such an interest in the work of the Committee of which he is Deputy Chairman, as to write a paper of this kind. Bridlington is to be congratulated upon the success of its water undertaking. When within thirty or forty years of buying out a company, and paying an extravagant price for its undertaking, as on the face of it Bridlington had, and on the top of that go to great expense in constructing new works, and then be able to provide water at a rate of 1*s.* in the pound, and out of the proceeds hand something over to the relief of the rates, the town must certainly have no reason to complain about the enterprise. The essential difference between a company's undertaking and a Corporation undertaking is this: a company's is carried on primarily for profit, and a Corporation's object is to give an efficient supply of water to the district. It appears to me that in a place like Bridlington the use of 43 gallons of water per head per day is excessive, and I venture to say the time will come when the Bridlington Corporation will have to consider how they can reduce the consumption per head. The time to do that, I think, is not when a shortage actually occurs, but when the supply is plentiful. I would not like to say the consumption could be reduced 50 per cent., but 30 or 40 per cent. should mark the decrease under a proper system of surveillance, and with 25, or at the outside 30, gallons per head per day the people would be abundantly supplied.

Mr. H. W. Smith: Mr. Silcock and Mr. Smillie have touched upon the sea defence works, and I should like to say, as one who has had some little experience with various types of sea walls, that I quite endorse what Mr. Matthews has said on the merits of the stepped-face wall. My experience in Scarborough has been that there is nothing like the amount of scour with a stepped-face wall that there is with a smooth concave-faced wall. With regard to the use of stone, I think that is a matter which every district will settle for itself. We have both stone and concrete walls which are answering their purpose admirably. Some of our concrete walls have been up twenty years, and, although there is at times a scour from the shingle it is not appreciable.

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Mr. Wakeford referred to the use of cold tar for tar painting. In Scarborough we use cold tar for painting both the roads and footways. This has been done for many years. My predecessor started it, and I have followed on, and we get most excellent results; but it must be applied in suitable weather. The road surface must be absolutely dry, and the weather warm. With these conditions I do not think it can be bettered. When it comes to tar-painting a tar macadam road, I quite agree that the boiling of the tar gives you a better result. In making an ordinary macadam road I have lately done away with chippings for binding, and have used a mixture of fine dust, ashes, and tar, grouting the road with this mixture, and following on the next year with tar-painting with hot tar. The most excellent results have followed from this method.

Mr. J. A. Iveson: I have followed Mr. Smith's method of dealing with roads, and got most excellent surfaces.

Mr. E. E. H. Burton: Mr. Matthews refers to having made a roof covering of reinforced concrete and Limmer asphalte, and says it is in every way water-tight. I have had some experience in flat roofs, constructed both with steel joists and concrete, and the newer method of reinforced concrete. Seeing that these roof slabs are only about four inches thick, there is a possibility of trouble with expansion and contraction, and although covered with Limmer asphalte, they are not always water-tight. I have frequently found cracks develop in concrete flats, and the asphalte, rendered somewhat brittle by exposure to the sun, appears to follow the concrete, and crack on the same lines. I should like to ask Mr. Matthews if he has had any experience of this nature, and if he makes any provision for expansion.

The President: I should like to endorse every word that has been said by the various speakers as to the excellent paper given by Mr. Matthews to-day. Many suggestions have been made, by means of which Bridlington may be further improved. May I offer one more suggestion that this enterprising town might at an early opportunity take in hand, as a matter of health; that is, the provision of a refuse destructor, a most important item, not only in a town like this, but in all our towns throughout the country? It may not be common knowledge to all you gentlemen that our friend Mr. Matthews is a great expert on sea defence work. He has carefully studied the defence of the coast against damage by the sea, and this coast suffers

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very badly indeed, and the paper which he read before the Institution of Civil Engineers was one of considerable importance and merit. I quite agree with him in his contention in that paper that it is quite time that the Government of this country took in hand some portion of this particular work. It seems a hardship to towns like this that they should have to bear the whole expense of protecting their coast. I think we ought not to forget, when we speak of the great progress which has taken place in Bridlington and other towns on sanitary, and other grounds, the work of our colleagues in office, the medical officers of health and the sanitary officers. They are a great assistance in reducing the death rate, and in looking after sanitary matters; therefore, we ought not to forget that they assist in the promotion of the health of a town.

MR. SMILLIE: Will Mr. Matthews be good enough to tell us what the street lighting department pays to the electricity department for the current for street lighting. It would be interesting to know whether or not, the street lighting department subsidises the electricity department.

MR. MATTHEWS: I am delighted there has been such a good discussion on the papers. Mr. Massie referred to the small number of empty houses in Bridlington. I should like to say that about forty houses are in course of erection, and plans were passed last month for twenty-two further houses. With regard to the screen chambers, there is one on the north side and two on the south side of the harbour. In each of these screen chambers the sewage passes through two screens of 1½-inch and ¾-inch mesh respectively, and the solids fall into a sump. Nothing passes into the sea that is likely to be a nuisance. During the summer months the sanitary committee are alive to this matter, and have a man going from one screen chamber to the other, seeing that the screens are working properly. The sumps are emptied every morning at five o'clock, and farmers in the district are only too ready to take the sludge for manure. With regard to the Town Hall, and the accommodation for officials, we are hampered very much by lack of accommodation. I have no doubt when you come again we shall be able to show you our new municipal offices. With regard to the sea wall, I am strongly of opinion that the best type is the stepped-face type, and I say this after seeing most of the sea walls in this country, and several on the continent, at Ostend and elsewhere. With regard to the tarring

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of the roads, we usually apply the tar cold; but, as the borough engineer of Scarborough has pointed out, the chief thing is to put it on in suitable weather. We find no trouble at all, and we are proud of our roads. As to the loans for ferro-concrete, I think we were very fortunate in getting loans for twenty-seven and thirty years, seeing that the Local Government Board have looked with disfavour on this material. I do not know why they should have taken up an attitude of that kind, seeing that this material is so extensively used by the War Office and the Admiralty. It seems, however, as if the Local Government Board are gradually coming to their senses, as these are the first loans for reinforced concrete work which have been granted for so long a period; we are pleased to let this information go to other boroughs. We have not yet received a letter from the County Council in reply to ours, with respect to the application for a tar-spraying machine. We have several miles of main roads in the borough, and we get nothing from the County Council in respect of these, and as we want a tar-spraying machine we thought it a good opportunity to ask them to supply us with it. We are hoping that the reply will be favourable. As to the cost of tar, we pay 9*s.* per barrel of 40 gallons. As to the housing scheme, the cost of the houses which we propose to erect varies from 178*l.* to 207*l.*, which includes the cost of land, drainage, footpaths, and everything. The Council, on Wednesday last, unanimously approved of the scheme. Mr. Silcock referred to the favourable condition of our town as to sewerage. The whole town falls towards the sea. The highest point is 200 feet above O.D., and we have no difficulty at all with regard to sewerage or sewage disposal. With regard to the groynes on the north foreshore, since their erection some few years ago we have between two and three million tons of sand more than we had before we put the groynes down. We are proud of our sands; I think there are few towns that can show a beach to equal ours at Bridlington. Mr. Brodie has said that at Blackpool they do not like groynes, but trust to their sea wall to protect them from the inroads of the sea. That course would have been absolutely impossible at Bridlington. The sea walls were being undermined before the erection of the groynes by me twelve years ago. It was a most serious matter, and we found it was necessary to go in for a system of groyning without delay. With regard to Mr. Wakeford's question as to private streets, no portion of the cost

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of sewers is included in the 4*s.* 6*d.* This rate refers to a 36 feet street, and five per cent. was added for supervision in each case. The automatic flushing tanks which flush the sewers have worked satisfactorily; there are fourteen of such tanks in use. We seldom put lampholes on our sewers. I do not like them; I put manholes in where I can. I much prefer artificial to natural flags, because they do not deteriorate with age; they keep in good order, and look much better. We have not done much in the way of concrete *in situ* footpaths in Bridlington. No pitch is added to the tar used on the roads. Where the roofs of our lavatories, etc., are covered with ferro-concrete and Limmer asphalte, they are absolutely watertight. We have one lavatory where the roof was constructed with steel joists and concrete, and it leaks like a sieve during heavy rains. A refuse destructor, town hall, and municipal common lodging house we hope to show you when you come again.

COUNCILLOR CHARLESWORTH: I may say it is the intention to reduce the charge for baths and W.-C.'s very materially. It has not been a question of making money out of the ratepayers by these additional charges, but a necessity. The Water Company was paying fifteen per cent. dividend when the Corporation bought the undertaking, but they were riding for a fall, and were taking all they could out of it. They knew they would get a good price for the works, and they did. With regard to Dr. Calvert's suggestion as to a softening plant, I know that in York they strongly object to having their water doctored; they do not like chemicals being put into the water. That is one reason why we have not gone in for softening. With a very soft water there is action on the pipes, and the risk of lead poisoning. By boiling the water we get it practically soft. It is as soft as Leeds water, after boiling. Leeds water contains two per cent. of hardness before boiling, and Bridlington two per cent. after boiling. As to the excessive consumption, I have been a strong advocate for reducing the consumption, and I am pleased gentlemen have spoken out as they have done. The consumption is far in excess of what it should be. As to corrosion, we can show Dr. Calvert some pipes laid down forty years ago, and they are practically in as good condition as when they were put in. We supply the electricity for lighting purposes at cost price.

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Mr. Frank Massie, Chairman of the District, entertained the Members to luncheon at the Britannia Hotel.

During the day the Members made visits of inspection to the Royal Princes Parade, Victoria Sea Defence Works, Beaconsfield Lavatories, the Marine Drive Lavatories and Shelter, the Pembroke Gardens, Fish Stand, Electricity Works, and Waterworks.

The Mayor provided Tea for the Members at the Waterworks.

COMMUNICATED DISCUSSION.

MR. J. S. BRODIE: I notice that there are still some 20 per cent. of your houses within the borough which have no water-closets. I hope this will be a steadily-diminishing quantity, until the whole borough is, as we are here at Blackpool, entirely a water-closet town. It would have been of interest if you had supplied us with a little fuller information in regard to your screening arrangements for the sewage before it is discharged into the sea. This is a subject coming now very much to the front, and any information which we sea-coast town engineers can obtain on this subject is very welcome. Also in regard to your waterworks, it would be interesting to be told how you stand in regard to the scale of hardness, as I take it the whole of your supply is from deep wells. You are doing obviously first-rate work in regard to your streets and roads, and one would be grateful to have a few particulars with regard to the intensity of traffic on your 2-inch Scotch granite bituminous-bound roads. I observe also that your asphalted footpaths are formed with tarred limestone, and I have no doubt that you find these more successful than the use of the primary rocks for this kind of work. Your statistics of wages are certainly very interesting. Your rates of wages are considerably lower—at least to the extent of from 10 to 15 per cent.—than what we pay here, none of the permanent labourers in my department being paid below the rate of 6*d.* per hour. In regard to the cost of your private street weeks, it would also be interesting if you would state the cost per foot frontage, including all road-making but exclusive of sewers, as the price given—4*s.* 6*d.*—seems incredibly low. Your remarks in regard to the sea defence works and sea-front improvement works are really very interesting, and you are to be congratulated upon the great success which you have achieved

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at Bridlington in regard to these works. I note your remarks in regard to the new sea wall. You will, I hope, excuse me if I differ with you in regard to the form of construction in the shape of steps which you seem to prefer. My criticism of this, which I am sure you will take in good part, is strengthened by the paragraph in your paper where I am entirely with you, when you state, "undoubtedly the most suitable stone to face a sea wall with is granite or basalt, especially where the foreshore is chiefly shingle, and H.W.O.S.T. rises several feet up the wall." Concrete blocks in such a case are hopelessly inefficient, and I very much fear that even your Bramley Fall rock faced stone may give trouble in the future, as nothing short of the hardest possible material will withstand the eroding action of the sea on an exposed coast. It appears to me that the stepped face, *pace* the forty years' experience of the Prince's Parade wall, must tend to wear smooth under the eroding action of the sea, whether it be a curved face or a straight face, and therefore that a face more or less smooth to begin with is really the best form of construction, and as regards the scour at the base of the wall, this, after all, is entirely a matter of the cross-section of such face, and, if such a wall is properly designed, the scour at the base is a negligible quantity. My considered judgment in regard to groynes upon a foreshore in front of a marine watering place is that at best they are a necessary nuisance. They certainly detract very much from the appearance and use by the public of the foreshore of a popular health resort, and here at Blackpool I have made up my mind to do without them altogether, and to spend my money on the sea defence works themselves, instead of groynes disfiguring my foreshore. I think this is a conclusion I have arrived at that will commend itself to engineers responsible for the amenities of their foreshore in popular marine watering places in the future. In regard to the tree-planting in streets, you are certainly to be congratulated upon the low cost you can plant trees for, as I cannot do anything like it. One would also like to hear if you find any trouble in inducing trees to take root and grow satisfactorily, as here at Blackpool, owing to the exposed nature of the place, it is very difficult to get trees to grow at all.

MR. E. R. MATTHEWS: In reply to the points raised in Mr. Brodie's letter, I would state that we are steadily increasing the percentage of water-closets at Bridlington. Water-closets have

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to be put into all new houses, and we hope that the time is not far distant when we shall be able to say that we have no sanitary conveniences other than water-closets in the town. As to the screening arrangements for the sewage, this has already been dealt with in the reply given to one of the members of the Institution who raised the point at the meeting. The hardness of the water was dealt with in Mr. Councillor Charlesworth's reply. As to the intensity of traffic on our tar macadam roads, some of these roads, such as Cross Street, Bridge Street, and the Promenade, are subject to a great deal of traffic, but none of it is what one might call heavy traffic, as would be found in an inland manufacturing town, for example; probably the heaviest loads that would pass over these roads would be loaded furniture vans and station trollies heavily loaded. As to the cost of private streets, this has already been dealt with in my reply to Mr. Wakeford's comments on the paper. As to the durability of Bramley Fall rock-faced stone, while granite or basalt, as I have said in my paper, are preferable for the facing of a sea-wall, they are both considerably more expensive than Bramley Fall stone; the old Prince's Parade sea wall at Bridlington, constructed nearly forty years ago, has needed no repairs, and has the appearance of lasting for a century. I still adhere to my opinion that a stepped-face wall is the best type to construct, for the reasons already set out in my paper. As to Mr. Brodie's remarks *re* groynes, I scarcely agree with him that these upon a foreshore are a nuisance, the seventeen that we have put down upon our north foreshore, so far from being a nuisance, are a great convenience to the visitors, who use these low timber groynes as a seat, and on some of these groynes in the height of the season it is difficult to find a vacant seat, the photograph which I showed to the members in the Council Chamber well illustrated this. As to tree-planting in streets, Mr. Crofts, our town's gardener, informs me that he does find difficulty, especially on the sea-front, in inducing the trees to take root. I thank Mr. Brodie for his useful criticism of my paper.

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WEST MIDLAND DISTRICT MEETING.

July 6, 1912.

Held in the Council Chamber, Town Hall, Stourbridge.

A. D. GREATOREX, M.INST.C.E., PRESIDENT, *in the Chair.*

THE Chairman of the Urban District Council offered the Members of the Institution a hearty welcome to the town of Stourbridge.

The President thanked the Chairman of the Council for the kind welcome he had offered to the Members of the Institution.

SOME MUNICIPAL WORKS AT STOURBRIDGE.

BY F. WOODWARD, *Member*, SURVEYOR AND ARCHITECT TO THE URBAN DISTRICT COUNCIL.

Generally.—1. Stourbridge obviously derives its present name from the bridge over the river Stour. The earliest mention of the town is in a deed of 1375, where it is described as "Sturbrugg." Stourbridge town is the head of a Union, a Petty Sessional division and County Court district, in the ancient parish of Oldswinford, in the Mid or Droitwich Division of Worcester. It is situated on the green borderland of the Black Country; on the north and east are the mining and manufacturing industries of South Staffordshire and East Worcestershire; on the south and west, attractive residential districts. It is separated from Staffordshire by the river Stour, which forms its northern boundary. In 1894 Wollaston was joined to Stourbridge, and the following year Upper Swinford also. The district has both a residential and

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industrial character. The chief manufactures in the district are (Messrs. J. Bradley & Co.) branded bar iron, where the first locomotive used in America, "the Stourbridge Lion," was made, fire-clay goods, including glazed bricks and baths, flint and other glass, leather and fellmongery goods, buckets and other galvanised sheet-iron articles, chains, anvils, vices, etc.

King Edward VI. Grammar School in the town was founded by Royal Charter in 1552 at the request of the inhabitants of the town of Stourbridge. Since that date it has been entirely rebuilt. Considerable extensions have been made during the last few years, which have provided accommodation for over three hundred boys. It is richly endowed, and one of the first in the county. The town and residential portion is on the New Red Sandstone formation, the other portion having a brick-clay surface overlying the coal and fire-clay measures.

2. *General Statistics.*—The estimated population of the urban district is 17,341; area, 1920 acres.

Population per acre, Stourbridge	23·78
" " " Wollaston	6·05
" " " Upper Swinford	3·49
Entire district	9·03
Rateable value	£67,017
Approximate number of houses	4250
Death Rate, 1911	13·09
Birth Rate, 1911	25·99

Rates.—District rates, Stourbridge, 3*s.* 10*d.*; Wollaston and Upper Swinford, 3*s.* 6*d.* Poor rate for Stourbridge, 5*s.*; Wollaston and Upper Swinford, 4*s.* 6*d.*; total, Stourbridge, 8*s.* 10*d.*; Wollaston and Upper Swinford, 8*s.* A penny rate brings in 230*l.*

3. *Roads.*—There are six miles of main roads maintained by the Council. The total annual cost is about 1250*l.* for ordinary maintenance and scavenging. The County Council make an annual payment towards the cost. The town roads are sixteen miles in length and cost about 1200*l.* a year in maintenance. The main roads are repaired chiefly with Rowley and Clee Hill granite, and the district mainly with broken slag.

Construction and Tar Spraying.—The Council have experimented with rocmac, tarmac, and tar grouting with success. The Council have decided to extend the use of tarmac in future where the gradients will allow. For some years before tar painting was done the chief main roads had become unbearable owing

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to the dust nuisance, liberal street watering did not abate the nuisance. For several years the chief roads have been tar painted. Last year 45,000 yards were done by machine, 8100 yards with bituminous compound, 12,800 with refined, and 24,100 with crude tar. The cost per yard was :—bituminous, 2·037*d.*; refined, 0·872*d.*; crude, 0·568*d.* The covering capacity was, bituminous, 4¾ yards to the gallon; refined, 7 yards; and crude, 8 yards. The cost of labour by hand the first year was 0·347*d.* a yard. By machine, 0·212*d.* The painting has considerably increased the life of the roads. Pot holes have diminished, which were caused largely by the constant watering.

4. *Street Improvements.*—Stourbridge, being an old town, has many narrow roads, and thousands of pounds could be spent in purchasing properties for desirable widenings; but, being a comparatively small one, it has to move slowly in this direction. Notwithstanding, the Council have during the last three or four years borrowed sums amounting to 5000*l.* for purchasing properties for street widenings, the chief of which is the Market Street improvement, opposite the Town Hall, just completed, and the Hemplands and Round Court Improvement, in hand, where twenty-six slum cottages have been demolished for the making of a new street. Every opportunity is taken to widen roads, and 3000*l.* has been spent on this work in various parts of the district out of revenue during the last ten years, and carried out by direct labour. Nearly all the land was given upon condition the Council made the road and refenced. During the same period a sum of 6000*l.* has been borrowed on loan for paving works.

5. *Tramways.*—In 1898 the British Electric Traction Company obtained orders to construct tramways in the urban district under the Dudley and District Light Railways Order and (extension) Order, and the Kinver Light Railways Order.

Many clauses were obtained for necessary street widenings, which were paid partly by the company and partly by the county and urban councils. The work of widening was carried out by the urban council and recharged to the parties concerned.

There are two miles of double track, and one mile of single track in the urban district. Eighty-seven lb. grooved rails were used, laid upon a bed of 6-inch cement concrete. Between the rails, and for 18 inches on either side, it is paved with 5-inch by 3-inch and 5-inch by 4-inch granite setts, the whole being maintained by the tram company.

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The High Street portion was too narrow for a single track up the centre, and a double line was laid as near to the kerb as possible. It is laid on 6-inch cement concrete, and paved the full width of carriageway with Jarrah wood blocks, and maintained by the Council and recharged to the company under an agreement. It is now only used for running the cars through to the Lye. At first the company started running through from Dudley; but, owing to obstructions by vehicles unloading, etc., and only one tram-car being allowed in the street at one time, the company found it impossible to continue the service owing to delays, and the terminus is now by the town clock, for which the High Street traders are very grateful.

Kinver Light Railway.—This railway is about four and a half miles in length, about one mile being laid as ordinary tramway on the main road in the urban district, and the remainder in the Seisdon rural district, Staffordshire, being laid at the side of the main road and on a private right of way through the fields. The construction of the latter part consists of 4½-inch girder rails dogged to transverse sleepers. Power is supplied from a generating station situated at Hart's Hill, about three and a half miles from Stourbridge. This station is equipped with three 100 k.w. d.c. generating sets through a battery sub-station at Amblecote, and is conducted to the cars by means of the usual overhead trolley. The Amblecote battery consists of 256 Tudor cells, and is for the purpose of keeping a steady load on the generators at Hart's Hill, and also to improve the average voltage on the trolley wires, that is, at times when the load is heavy, the battery discharges and helps the generators; and when few cars are running the generators then charge the battery. At times of heavy traffic a Diesel generating set, situated on the Lye route, is also put into service. This set is of 100 k.w. capacity, and for Bank Holiday loads power can also be taken from the Midland Electric Corporation power station, Ocker Hill, through a 150 k.w. generator situated in Amblecote sub-station. Sixteen thousand people have been carried on this light railway on a Bank Holiday.

6. *Refuse Destructor.*—The destructor plant was erected in 1904. It consists of three furnaces, each with 30 feet grate area, capable of destroying thirty tons in twenty-four hours. The average daily quantity consumed is twenty-two tons. The furnaces are of the usual Horsfall type, erected at that time with back

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feed. The furnace gases pass through a Lancashire boiler on their way to the chimney shaft, and also through a Horsfall centrifugal dust catcher. The stack is 120 feet high, and the whole plant is housed in substantial brick buildings. The site is three acres in extent, and is used for depositing the clinker and ash. The total cost was 5325*l.*, including engineer's house; but of this sum 1000*l.* was spent for electric light purposes.

After the abandonment of the electric light scheme it was decided to carry a steam main a distance of 120 yards, for supplying the engines at the sewage pumping station with the surplus steam. The steam generated mainly goes to supply the steam jets for the forced draught, the surplus being responsible for pumping one-third of the sewage. This quantity does not come up to expectations owing to the supply being very intermittent. The total tonnage destroyed per annum is 5500. The cost last year per ton for destroying, including all labour, upkeep, and rates and taxes, was 18·940*d.*

7. *Public Baths.*—The public baths were erected in 1901, from the Author's designs, at a total cost of 5133*l.*, including water supply and engineer's house. Twenty-seven years' sanction was obtained for the erection and five years for the water supply. The cost, excluding site and water supply, but including boilers and heating arrangement, was 5½*d.* per foot cube. The boiler-house, laundry, pump-room, and stores are situated in the basement. The swimming hall is 93 feet by 46 feet, and the pond 75 feet by 28 feet. Dressing boxes are provided on two sides, and 5-feet gangways, except at the deep end of bath, which is 12 feet. Galleries are provided over the dressing boxes, and are approached by two staircases each side of main entrance. In connection with the swimming bath is a lavatory, soap bath, and shower, and a committee room leading from the gallery. The swimming-bath walls were constructed in brickwork in cement, having a ¾-inch rendering of cement in two layers before the glazed lining was put in. The bottom was constructed with 9-inch cement concrete and rendered as walls before laying glazed brick bottom. The pond has been absolutely watertight from the first. There are two entrances for men and women. Between each corridor entrance are situated the pay office and waiting-room, and at the side of each entrance are six slipper baths for men and three for women. The interior walls of swimming hall and slipper baths are faced with Ruabon

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best facing bricks relieved with buff cornice. The roofs are match-boarded and top lights provided with opening casements. The front elevation is faced with best local facings and relieved with buff terra cotta dressings. The heating was carried out by Messrs. Jones and Attwood, of Stourbridge, on the low-pressure hot-water circulating system. The cost of this portion of the work was 350*l.*, which included connections and fittings to slipper baths, boilers, and drying coils. This sum is included in the total amount given above. The system is simple and much cheaper than steam in first cost and maintenance. In our case the superintendent attends to the whole except in the swimming season, when a youth is engaged. The Author is of opinion that for small baths this system is very satisfactory and much more economical than steam, and occupies very little space. A powerful boiler is fixed below the level of the bath and circulates through galvanised pipes from the boiler to the bath. The flow pipes are connected at the shallow end and near the bottom of the bath, returning from the deep end and from the bottom of the bath. A separate boiler is provided for the slipper baths and heating pipes, so that the upkeep is very small when the swimming bath is closed. The annual water consumption is approximately 3,500,000 gallons for the whole of the establishment. The fuel consumption is 110 tons, or about 31,818 gallons of water per ton of fuel used. The required temperature of 70 degrees is easily maintained. The water for filling the pond is pumped and heated through the boiler, and no complaints are received owing to bad circulation. The borehole is 10 inches diameter and carried through the new red sandstone to a depth of 250 feet. The borehole is lined to a depth of 60 feet. The pump is one of C. Islers and Co. improved deep-well pumps, capable of yielding 6500 gallons per hour. Ample supply has always been obtained, and as the five years' loan charges are paid off, the cost of water is now under a penny per thousand gallons. The average annual upkeep of the baths including wages, rates and taxes, and repairs, etc., during the last seven years was 330*l.*; annual charges for repayment of loans, 260*l.*; average receipts, 250*l.*; average cost per annum to the ratepayers equals a 1½*d.* rate.

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FREE LIBRARY, TECHNICAL AND GIRLS' SECONDARY SCHOOLS.

8. These buildings were erected in 1904 from the Author's designs, and extended three years ago, at a total cost of 14,000*l.* Mr. Carnegie contributed 3700*l.* towards the cost of the free library portion. The cubical contents are 465,628, which works out at 6¼*d.* per cube foot.

The following is a brief description of the building:—

Basement.—Carpenter's shop, 39 feet by 22 feet; blacksmith's shop, 40 feet by 21 feet; recreation room, 40 feet by 21 feet; and dining-room for girls, 40 feet by 38 feet, with heating apparatus and stores.

Ground Floor.—Free library, consisting of main entrance and corridor, 47 feet by 8 feet; news room, 40 feet by 38 feet; ladies' room, 17 feet by 13 feet; magazine room, 40 feet by 21 feet; lending library, 41 feet by 25 feet (open access system), librarian's room and stores. Approached from a separate entrance are two caretakers' rooms, modelling room, 26 feet by 21 feet; cast room, 21 feet by 12 feet; cookery room, 26 feet by 21 feet, and store.

First Floor.—School of Art, namely: Elementary room, 43 feet by 21 feet; advanced room, 44 feet by 21 feet (which can be converted into one room, 87 feet by 21 feet, by folding partition); life room, 23 feet by 21 feet; painting and antique room, 26 feet by 21 feet; mechanical drawing room, 38 feet by 21 feet; with Secretary's room, lavatories, and cloak-rooms.

Second Floor.—Girls' secondary school, namely: Five classrooms, each 23 feet by 21 feet; chemistry room, 26 feet by 26 feet, with balance room; lecture theatre, 38 feet by 21 feet, with lavatories, cloak-rooms, and teachers' rooms.

Two staircases are provided at each end of the building on each floor. The corridors and staircases are constructed in concrete, and the floors of all rooms are made sound-proof. All walls are plastered throughout except in the basement. There are 4660 cubic feet of terra cotta as enriched work to the elevations, supplied by the Ketley Brick Co., of Brierley Hill.

9. *Tar Macadam Plant.*—A plant for heating and mixing tar macadam has just been erected at the Council's depôt at a total cost of 350*l.* The heating arrangement consists of a 2-feet revolving cylinder 10 feet long inside a 3-feet steel shell. The

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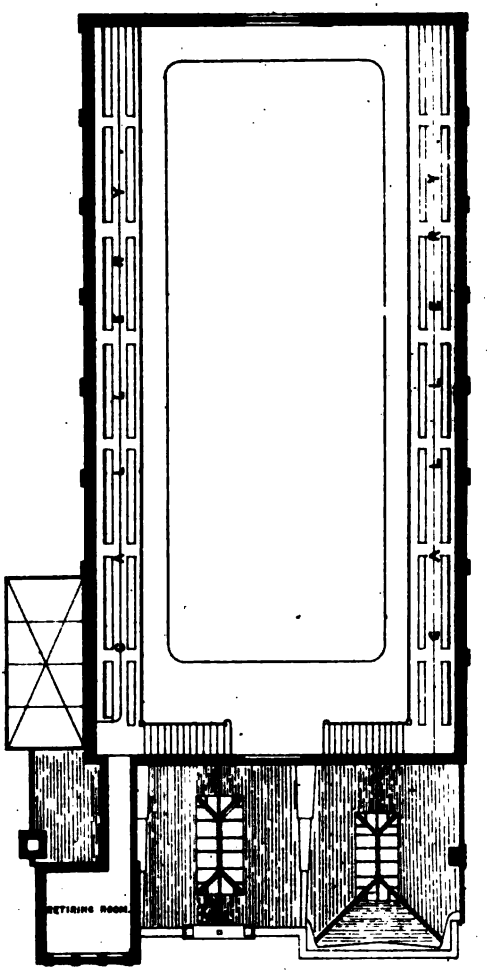
PLATE Nº 1.

OUNCIL.



GALLERY PLAN.

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whole is built up on brickwork with an ordinary furnace. The heat passes round the cylinder and shell, and returns through the bottom of shell and round to chimney. This work, together with the mixer was supplied by Messrs. Thompson and Southwick of Tamworth. The power is obtained from a 5½ B.H.P. gas engine. The whole is covered with a galvanised iron shed, 51 feet by 20 feet. It is estimated that with this plant 40 to 50 tons a day can be heated and mixed by three men.

10. *Pleasure Gardens.*—In 1903 the Council purchased, at a cost of 2000*l.*, four acres of land out of gas profits, for the purpose of cutting a new street and providing pleasure gardens. The Author prepared designs for the laying out of about three acres, which was done by contract at a cost of about 800*l.* provided by public subscriptions. The Council have now under consideration the purchase of some twenty acres of land for a park, as the present grounds are not large enough.

11. *Public Mortuary.*—A public mortuary was erected in 1909 out of revenue from the Author's design, on land adjoining the baths, at a cost of 225*l.* It consists of a room 18 feet by 18 feet, fitted up for post-mortem, and open entrance hall (where jury can view the body instead of in mortuary), and enclosed yard.

12. *Sewage Disposal Works.*—In 1891 a meeting of the Association was held at Stourbridge, when Mr. Fiddian gave a paper on the sewage disposal works, so that it is only necessary to give a brief description. The disposal of the sewage is dealt with by the Stourbridge Main Drainage Board. The works comprise main sewers converging at a pumping station, from which the sewage is conveyed through a rising main to a farm about two miles distant, and there dealt with by broad irrigation. The lift is about one hundred and fifty feet. The area of the farm is 296 acres, of which 275 acres is let to a tenant at a rental of about 250*l.* per annum. The subsoil consists of from 5 to 8 feet of loam sand with a few pebbles overlaying the rock of the New Red Sandstone formation. The total quantity of sewage pumped last year was 344,000,000 gallons. The area of Board's district is 2574 acres, with a population of 20,500. Outside population served, 6000, in addition. The quantity of fellmongers' waste fluids in the sewage is estimated at ⅛ of total. The capital outlay was 37,000*l.*, the bulk of which is nearly discharged. The annual expenditure is 2700*l.* The whole of the system was carried

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out about twenty-seven years ago, on report of, and to plans prepared by the Author's predecessor, Mr. William Fiddian, who still holds the position of engineer to the Board. There are 20 miles of collecting sewers in the Urban District, which are flushed weekly by twenty-five automatic flushing chambers and by cart. They were laid by Mr. Fiddian in 1885, at a cost of 11,000*l.* These loans, together with the Council's portion of the Drainage Board loans, will be paid off in three years, equal to about a 7*d.* rate. The surface water is dealt with separately as far as possible, the old sewers being utilised for this purpose. The system of ventilation is by surface grids, but these have been replaced with solid ones where complaints have arisen from time to time, and shafts erected. Three Webb's ventilating lamps have been erected, which are partly lit all day, for which an additional 1*l.* a year is paid for each lamp.

13. *Privy Conversion.*—During the last few years about eleven hundred privies have been converted into water-closets, and there are now not more than half a dozen privies in the Urban District. Credit is due to our sanitary inspector for obtaining this result. Under section 39, sub-section 4 of the Public Health Act Amendment Act, 1907, local authorities have to contribute one-half the cost for these conversions, but in the Author's opinion sufficient powers exist without resorting to this Act, and he cannot think that many local authorities will put into force this section, spending ratepayers' money improving private property.

14. *Cleansing of Ashpits, etc.*—Some eighteen months ago this work was transferred from the sanitary to the Author's department for economical reasons. A considerable saving in horse hire has been made on the two departments due to one helping the other; 5360 loads were removed in 1911, at a cost of 580*l.*, including establishment charges. About one-half the houses are provided with ashbins, which are emptied weekly.

15. *Underground Convenience.*—A small convenience has been erected near the Free Library, at a cost of 250*l.* out of loan. It consists of a four-stall urinal and three penny-in-the-slot water-closets. Without an attendant the W.-C. locks get abused, and considerable damage is done, at times.

16. *Street Lighting.*—The twenty-two miles of roads are well lighted with 545 lamps at a cost of 1500*l.* a year, which sum includes all maintenance. All are fitted with incandescent burners and lighted all the year round. The lamps are as follows:—

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475	one light	100 c.p.
1	four „	400 „
2	three „	900 „
1	three „	300 „
66	two „	200 „

The gas works (which includes large urban and rural areas outside the Council's area) belongs to Stourbridge Council. The works are situated outside the urban area in the adjoining county of Stafford, and are a very valuable asset to the town. Two-thirds of the profits are devoted to the relief of the rates, equal to an 8*d.* rate.

17. *Town Hall Offices.*—The Town Hall was erected on part of the Market Hall site in 1887 at a cost of 4000*l.*, by public subscription, as a Jubilee memorial to the late Queen. It will hold about one thousand two hundred persons. The architect was Mr. T. Robinson of Stourbridge. The Town Commissioners erected in conjunction with the hall, public offices, fire station, and council chamber, at a cost of 2400*l.*

18. *Markets.*—History states that the original Town Hall or Market House was taken down in 1773, for the necessary purpose of widening the carriageway in the centre of the town. A new Market Hall was erected and opened in 1827, at a cost of 20,000*l.*, including old houses and the building of two shops. Unfortunately no provision appeared to have been made in the Act relating to the old Market Hall for the repayment of the loan obtained for its erection, and this omission was only rectified by an Act in 1891. The existing Market Hall has just been entirely renovated, at a cost of 850*l.*, under the Author's supervision.

19. *Fire Brigade.*—The Council provide accommodation for Fire Brigade in the Town Hall buildings. The brigade is a voluntary one, but supported by the Urban Council, who pay duty-man's wages and house rent, and for occasional hose, etc., otherwise the brigade is supported by voluntary contribution.

20. *Incorporation.*—In 1883 a strong effort was made to obtain a Charter of Incorporation for the town, to include some of the adjacent districts, but the scheme [illegible]posed owing to strong outside opposition. It has [illegible] the public during the last eighteen months, ar[illegible] far that a petition has been forwarded [illegible] petitioners are seeking to obtain a [illegible]

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its present area before considering any proposal for including some of the adjacent districts.

21. *Infectious Diseases Hospital.*—The Stourbridge and Halesowen Hospital Committee comprises the areas of Stourbridge, Lye, and Wollescote, and Halesowen, with a population of about fifty thousand. The hospital is situated about four miles from Stourbridge. It was built in 1899, at a cost of 10,000*l.*, and has accommodation for forty-eight beds. The architects were Mr. A. T. Butler and Mr. H. T. Hare. A small-pox hospital has just been erected near, with accommodation for eight beds.

22. *Cemetery.*—About eleven acres of land were purchased in 1876 for the purpose of a public cemetery. The total cost of the work was 8500*l.*

23. *Waterworks.*—The town is supplied with water by the Stourbridge and District Water Board. The works have during the last three years been purchased from the Company by four local authorities within its area. They are explained in Mr. Fiddian's paper, the consulting engineer to the Board. The engineer and manager to the Water Board is Mr. W. B. Cleverly.

24. *Housing and Town Planning Act*, 1909.—The Council have adopted this Act, and the Committee have the matter under consideration. As the future development of the town will be on the residential side, the Author is hoping that the Council will shortly see its importance. The Author has already planned out certain areas.

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NOTES ON THE STOURBRIDGE AND DISTRICT WATER BOARD'S UNDERTAKING AND RECENT BORING OPERATIONS AT THE COALBOURNBROOK STATION.

By WILLIAM FIDDIAN (*Member*), Consulting Engineer to the Board.

A little over two years ago the Stourbridge and District Water Board acquired by Parliamentary authority the undertaking of the Stourbridge Waterworks Company. The population served is about forty thousand, and the present consumption of water about one and one-third million gallons per day. The supply is obtained from three pumping-stations, known as Mill Meadow, Coalbournbrook, and The Tack, with wells and boreholes in the Bunter measures of the New Red Sandstone. These stations are in the valley of the river Stour, Mill Meadow being about three-quarters of a mile above Coalbournbrook and The Tack a similar distance below. The waters obtained from Mill Meadow and Coalbournbrook have each 25 degrees of hardness, whilst that of The Tack has only 12 degrees. This difference appears to be due to the Tack borings being in the lower sections of the Bunter sandstone, where they outcrop at the lip of the basin in which the water is impounded. Coalbournbrook pumping-station is situated on the deepest portion of this basin.

In a recent report presented to the Board by the Author it was recommended that, for purposes of economy in pumping and the securing of an improved supply, both as to quantity and softness, Coalbournbrook station should be adopted as the main source of future supply, that the existing 20-inch borehole should be deepened from 200 feet as then, to 400 feet or more, and a new engine-house with high-duty pumping plant erected, also an additional reservoir for the low-level service (in more suitable position and at 40 feet higher level than the present one) should be provided with the requisite pumping and

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distributing mains for the rearrangement of the high- and low-level areas. Great economies are expected from (*a*) The concentration of the pumping at one station; (*b*) The use of high-duty pumping plant on all but extraordinary occasions, and (*c*) A better division of the two areas, which will reduce the supply required by the high level to about one-half of that at present.

The works are now in progress.

The main purpose of this paper is to describe the work done in deepening the 20-inch boring at Coalbournbrook, and particularly the separation of the upper and harder water of this borehole from the softer water met with in its deepened portion.

It should be explained that the original supply was taken from a well about fifty feet deep with a 7-inch borehole to a depth of 140 feet from the surface. At this depth a large quantity of water was met with, and further boring was considered unnecessary. In later years after the erection of additional pumping plant the late Waterworks Company desired to increase the supply from this station, and it was then that the 20-inch borehole was put down at a point some sixty feet distant from the well. At 138 feet from the surface the boring operations caused a marked discoloration of the water in the well, and, as a supply from this source had to be kept up, could only be carried on intermittently; so that, presumably on this account and because of the increase of water already obtained, operations were stopped when a depth of 200 feet was reached. From a knowledge of these and other facts, it became evident that a horizontal parting in the sandstone of considerable water-carrying capacity existed between the 20-inch borehole and the bottom of the 7-inch bore from the well, and that the bulk of the water supply was obtained from this parting.

When considering the problem of obtaining increased and improved supply of water for the undertaking on its acquirement by the Board, the Author found it practicable to make alterations at The Tack pumping station, by which Coalbournbrook station could be shut down during periods of ordinary consumption of water so as to allow of the 20-inch boring being continued without discoloration of the water supply.

Starting from the existing depth of 200 feet, the New England Boring Company, the contractors for the work, carried the 20-inch bore at its full diameter through the pebble beds and about eighty-five feet into the lower bed of the Bunter sandstone,

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making the total depth 500 feet. This work was done by the method described in a paper read at the Guildford meeting ("Proceedings," 1910–11, pp. 258, 259), and with considerable rapidity except when passing through layers of marl and loose pebbles, some ten feet of which were encountered at the base of the pebble beds. For marl or such-like strata the older percussion method of boring is undoubtedly the better, but in this instance the layers were thin and did not warrant a change of method. The loose pebbles gave considerable trouble, and had to be ground away by the revolving tool. A few pebbles came to the surface uninjured by the tool, but they must have fallen from the side of the borehole into the receptacle for *débris* on the top of the tool after it had passed below the bed of pebbles. It is very probable that a change to percussion methods would not have improved matters, as there would be a liability of disturbing and having to deal with a larger quantity of pebbles.

Tests were made at intervals during the boring operations (by means of the existing permanent pumping plant) to find, as far as possible, the extent to which the supply of water had been increased, and samples were taken of the water obtained below 200 feet from the surface during pumping, to ascertain the character of the new water. By means of a comparison of the records of the levels of water in the well and the 20-inch borehole respectively before the boring commenced with those taken at the several stages of its progress, the conclusion was arrived at that a total quantity of above two and a half million gallons of water per day would be obtainable at this station.

The quantity of water coming from the lower portion only of the 20-inch borehole having been estimated to be more than the Board's present requirements, and its hardness found to be 12° or about one-half that of the upper water, and its quality excellent, it was decided to attempt to make a controllable separation of the two waters. This was most successfully effected in the manner now to be described.

The 20-inch borehole as originally put down was lined with 20-inch steel tubes to a depth of 110 feet. This lining has now been extended some 45 feet with 16-inch tubes. It was sealed at the bottom to the side of the borehole by being lowered into 6 feet of liquid cement held up by a plug temporarily formed in the borehole. When the cement had set the portion projected inside the tube and a similar portion of the plug below were cut

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away. The joint at the connection of the 20-inch and 16-inch tubes was also made with liquid cement, a packing ring between the two tubes about six feet from the top of the smaller tube preventing the cement grout passing down below it. By this means an annular space was left between the 16-inch tube and the rock side of the borehole from 110 feet to 155 feet from the surface, between which points (at 138 feet) the before-mentioned parting gives communication with the well borehole. When this work was complete it was found that the object aimed at had been realised, as the lowering of the water-level in the well 40 feet only slightly affected the level of that in the 20-inch borehole.

The 20-inch borehole has been connected to the well by a 15-inch cast-iron pipe controlled by two sluices. The level of this connection is 35 feet below the top of the borehole, and the standing water-level is 2 feet below the top. To make the connection, a shaft was sunk between the borehole and the well (some 10 feet from the former), and a heading driven in the sandstone rock in both directions. The method of attaching the 15-inch branch to the 20-inch bore tube whilst under a head of 33 feet of water was that used for water mains by Messrs. J. Ruscoe and Co., of Manchester, from whom the necessary cutting tool was hired. The suction pipes of the pumping plant to be erected will be taken down this shaft and connected to the 15-inch horizontal pipe between the two sluices before mentioned. By this arrangement water can be obtained from the 20-inch borehole only, from the well only, or from a combination of both sources of supply in such proportions as may be desired.

Upon the connection of the 20-inch borehole to the well by a pipe it became possible to make a direct pumping test of the yield of the former. This proved to be practically what it was estimated at before the upper and lower waters were separated, namely, over one and a half million gallons per day.

The new plant will consist of a triple expansion rotative steam engine with vertical and inverted cylinders and direct single-acting ram pumps, capable of pumping one and a half million gallons per day with a lift of about three hundred feet. This will be used for low-level requirements. For high-level service it is intended later on to remove and instal here the high duty Worthington engine at present at Mill Meadow Station, the capacity of which is half a million gallons per day against a head of about four hundred and fifty feet.

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When the whole of the new works are complete, the demand for the low-level area is expected to be about one million gallons per day, and for the high-level area about three hundred thousand gallons per day.

The advantage of having all the pumping at Coalbournbrook instead of being spread over three stations is unquestionable. The plants at Mill Meadow and The Tack and the existing pumping engines at Coalbournbrook will in future be maintained for ordinary stand-by purposes, and for use in case of exceptional demand for water.

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NOTES ON THE STOURBRIDGE GAS WORKS.

By C. H. WEBB, M.Sc., Assoc.M.Inst.C.E.,
Gas Engineer.

The works were established in 1835 by a company of six shareholders, but it was not until twenty years later that they were incorporated by the Stourbridge Gas Act of 1855. The maximum price of gas mentioned in the Act is 6*s.* per thousand cubic feet, and there is included a Purchase Clause in favour of the local authority. In all other respects the Act is in the usual form. The undertaking was purchased by the Urban District Council of Stourbridge as and from December 31, 1892, at a price of about 100,000*l.* The works are not situated in the area of the Stourbridge U.D.C., but immediately over the boundary, in Amblecote Parish, Staffordshire. The present district supplied comprises Stourbridge, Amblecote, Lye, Wollescote, Pedmore, Hagley, Clent, Belbroughton, and part of Wordsley, with an area of 15,308 acres and a population of 39,915. The output of gas is high in proportion to the population, the area having, in addition to residential parts, large manufacturing districts with a working-class population. A large percentage of the gas is supplied for power and other trade uses, and there is also a heavy consumption by prepayment meters, gas fires, and cookers. The following comparison will show the progress made in the period that the works have been the property of the Urban District Council:—

	1892.		1911-12.
Annual make of gas	96,000,000 c. ft.		231,182,000 c. ft.
Main mileage	37		60
No. of consumers	1340	ordinary	2243
		prepayment	5363
Public lamps	676		825
Tons of coal carbonised	8457		21,136

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	1892.		1911–12.
	£		£
Capital	47,500	(balance of loan) ..	95,172
Gross profit	4,787	.. ..	11,366
Price of gas	2/8	2/8, 2/6, 2/–, 1/9, and 1/6 (according to quantity and use)	
Gas cookers in use ..	nil	.. ..	2634
Slot meters	nil	.. ..	5363

The plant comprises: Retort house, containing eight beds of eight retorts (21 feet by 22 inches by 16 inches) with Klonne regenerative furnaces and worked with West's manual machinery; vertical water-cooled tubular condenser; two steam-driven exhausters; Livesey washer; rotary washer; five purifiers (30 feet by 20 feet); station meter; three gasholders, combined capacity 1,100,000 cubic feet: pressure raising or boosting plant and station governors (20 inches, 16 inches, 12 inches, and 12 inches safety governor). Humphreys and Glasgow Carburetted Water Gas Plant, of half a million cubic feet, is now being erected, and two Lancashire boilers (24 feet by 8 feet diameter), to replace old egg-ended ones now in use, are being installed.

The works are served by a high-level railway siding connected with the G.W.R. for delivery of coal, sulphuric acid for the manufacture of sulphate of ammonia, for stores to cooker repairing and fitting shops, and the removal of sulphate of ammonia, oxide of iron, etc. There is also a low-level railway siding for loading coke, and the tar produced can be loaded into boats on the canal adjoining the works by gravity from the sales tank. In view of the demand for tar for road purposes, Wilton's Tar Dehydrating Plant has recently been installed, and a description of this will perhaps be of interest. The special feature of this particular plant is that it is on the enclosed system, the tar being dealt with in a slow continuous stream instead of in bulk.

By this means the constancy of the finished product is more readily assured, and this is an important point when working to the Road Board's specification, which can be done with this plant. The principle of the process is that the tar is heated (to about 160° C.) when under pressure (about thirty lbs. per square inch), and then released, when the water and light oils, being at a temperature higher than their respective boiling points, are evaporated, and leave the dehydrated and acid-free tar behind. The plant at Stourbridge is capable of dealing with one hundred gallons of crude tar per hour. The tar is supplied from the

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land sale tank by gravity into a suction or feed tank, from which it is continuously pumped through a preheater or economiser, the coils of which are surrounded by hot dehydrated tar. After absorbing some of the heat in this, the crude tar then passes to the still, which is a brick structure containing about twelve laps of coiled piping, heated by a small breeze furnace with forced draught. The crude tar when passing through the coil is still further heated, and on leaving the still the pressure is suddenly reduced in the vapour box, where there is a free space provided. The water and light oils being at a high temperature are vaporised, and leave the tar, which latter flows away through the preheater, where it parts with some of its heat, on to the store tank for sale. From the top of the vapour box the vapours pass through a coiled condenser surrounded by cold water, and thence to the receiver, where the ammoniacal liquor and light oils separate by gravity. The liquor is run back to the works well, while the light oils are barrelled and sold. The plant is simple, easily worked, and, from the reports received from other works where the process has been carried on for extended periods, gives very little trouble. It is necessary to obtain a certificate of registration under the Alkali, etc., Works Regulation Act, 1906, and the plant is regularly examined by the Government Inspector.

As the greater proportion of the dehydrated tar will probably be required in the summer months, when the gas works output is at a minimum, it is essential that there should be ample storage for crude tar, and also to allow for rushes of work on the roads when the weather is fine, there should be good storage for the finished product. As road engineers you are doubtless most keenly interested in keeping the cost of the dehydrated tar as low as possible, and, consequently, your attention should be directed towards ensuring that the barrels used for packing should be treated by your men with the greatest care, and returned promptly. To pack a ton of dehydrated tar five barrels are required; cost at present prices 5*s.* each. As the cost of these barrels has to be charged in the price of the tar it will be seen that if the barrels can be made to last an increased number of journeys, say eight instead of six, before being scrapped, the cost of packing per ton is reduced from 4*s.* 2*d.* to 3*s.* 1½*d.*, or over 1*s.* per ton.

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DISCUSSION.

MR. J. S. PICKERING: I propose that a very cordial vote of thanks be given to the Authors of the papers. I think Mr. Woodward is to be congratulated upon carrying the work out at such a small cost. The main roads only cost 200*l.* a mile, and the district roads 75*l.* That seems a very low cost of maintenance. It is due probably to the narrowness of the roads and the low price at which the material is obtained. I should like to ask Mr. Woodward whether the cost given includes the tar-painting, which must be from 30*l.* to 40*l.* per mile. If that is so, the upkeep of the roads is exceedingly small. I notice on the main roads two descriptions of stone are used—Rowley and Clee Hill. I would like to ask whether one is better than the other, and if so, in what respects. The Council are fortunate in being able to obtain broken slag for their district roads; certainly it makes a cheap road; whether it is sufficiently substantial with the present traffic I am not able to say. Perhaps Mr. Woodward will be able to say whether it is economical. I notice three kinds of tar are being used—bituminous, refined, and crude. Will Mr. Woodward tell us what he finds to be the advantages of these different kinds; and whether the cost of the bituminous tar makes it desirable to use it in preference to the cheaper kind. Then I notice the Corporation possess a modern destructor; but there seems to be some disappointment as to the quantity of steam produced, and I am rather surprised to find, in reading the paper, that the steam mainly goes to supply the steam jets. I cannot understand it at all, because the makers say that the steam required for forced draught is only from 5 to 10 per cent. I do not know whether Mr. Woodward has thought of using a fan instead of the steam jets, as it seems the most economical form of obtaining a forced draught. I notice also that the steam is carried a distance of 126 yards. May I ask whether it is superheated, and if not, is there not a great loss from condensation. The water in the swimming bath, I understand, is warmed by the circulating system. Mr. Woodward does not give us the size or description of the boiler; he simply calls it a powerful boiler. Perhaps he would not mind telling us what kind of boiler it is, and why galvanised iron pipes are used for circulation. Also whether there is a pump

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used in connection with the circulation of the water. The Council are to be congratulated upon being able to let their sewage farm for a rent of 250*l.* per annum. Although less than 1*l.* per acre seems low compared with other farms, it is a fair figure, as many authorities show a considerable loss on sewage farms. Then I would like to ask whether the Webb lamps which are only partly lighted each day are satisfactory; also whether the automatic flushing tanks used on the sewers are satisfactory. Mr. Woodward refers in the latter part of his paper to the Housing and Town Planning Act, and states that that Act has been adopted by the Council. I would remind Mr. Woodward that the Act is not an adoptive one; it is applicable without being specially adopted. Referring to Mr. Fiddian's paper, his description of the method of separating the upper from the lower water is exceedingly interesting. Reading the paper alone it is rather difficult to follow the method adopted; but since coming into the room I have had the advantage of seeing the diagram on the wall, and the matter is now made perfectly clear. It is an unusual practice which has been resorted to; it has been a great success, and Mr. Fiddian is to be congratulated upon the work.

Mr. Sholto Douglas: I have great pleasure in seconding the vote of thanks which has been proposed to the Authors of these very interesting papers. I should be glad to know how much the County Council pay towards the maintenance of the main roads, and whether what they pay is by way of an annual grant on a contract extending over three or five years, or whether it is an annual adjustment based on the amount actually expended. Then I wish to know on how many of the six miles of main roads there is a tramway track, because that has a considerable bearing on the cost of maintenance. As to tar-spraying, Mr. Woodward is to be congratulated on the very low cost at which he is able to do his crude tar-painting. I cannot do it under a penny per square yard, because I pay heavily for my slag dressing. Does this figure of 0·568 of a penny include dressing? if so, what dressing is used and what is the cost per ton? I am interested in fellmongers' waste, and I should like to know the results of an analysis of the waste as discharged into the sewers, and also of an analysis of the crude sewage containing that waste. With respect to street lighting, the cost per lamp works out at a little less than 2*l.* 9*s.* per annum.

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That is an exceedingly low price, especially if the lamps are burning all night. I should be glad to know how much you pay the gas committee for public lighting purposes. With respect to the cemetery, the cost seems somewhat high, therefore it would be interesting to know if it was necessary to subsoil drain the site. If so, I should like to know if any trouble has been experienced with the drainage from the cemetery; whether it is treated in any way or discharged straight into the watercourses. With reference to Mr. Webb's paper as to the treatment of tar, I should like to know the cost of the plant which has been installed for dehydrating the tar, and the cost of the treated tar as compared with crude tar. That is, the cost in bulk.

MR. A. J. DICKINSON: With regard to the destructor, I should like to ask the number of stokers employed, the wages paid, and the hours worked as regards shifts. With regard to the swimming bath, there is the inevitable loss, but I do not think the ratepayers of Stourbridge should feel altogether sorry about that, because I think a swimming bath and slipper baths are a boon to the community, even if they are a burden on the rates. My experience is that it is not profitable to keep baths open in the winter. My Council has bought land at from 50*l.* to 82*l.* per acre. We, too, have an underground convenience, and owing to the town being too small to justify a caretaker being there all the time, we find it is most grossly abused. My own Council had the opportunity of buying the gas works and missed it, and then entered into the electric light scheme, which is costing the town 1000*l.* a year from the rates.

MR. W. O. THORP: With reference to the main roads, I should like to remark upon their low cost, and to ask whether the amount named is the sum paid by the County Council or the actual cost of the roads. If it is the cost of the roads I should like to ask whether it is wholly repaid by the County Council, or only a proportion is repaid, and if so what proportion. I think all Councils are well advised in the case of urban roads to send in a bill for their maintenance each year, and not enter into any contract. At Malvern I find, owing to the increased amount of motor traffic, our main road bill has been mounting up year after year, and if we had entered into any contract we should have come out very badly. We had a conference a few years ago as to obtaining a grant for watering, which

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proved abortive, but we have got something more satisfactory in tar-spraying. But unfortunately the County Council do not offer us anything like sufficient for tar-spraying the roads. At Malvern the County have offered us 30*l.*, whereas I propose to spend 250*l.* That is not altogether satisfactory from the main road or the Council point of view. I notice also that the cost of tar-spraying in Stourbridge is particularly low. I cannot do this work under a penny. However, I have to buy tar from Stourbridge, so the railway charges naturally cause the cost to mount up. In Stourbridge you buy it from your own works and get it at cost price. I should like to ask the amount of tar which is used in the tar-mixing plant. We do all our mixing by hand, and I find by using about 9 gallons of tar to the ton of stone I am able to get a very satisfactory tar macadam. We have some quarries adjoining my district where they mix with a mechanical plant. They use 50 per cent. more tar, and probably they are wasting a good deal of tar with the machine they are using. Speaking as the chief officer of a fire brigade, I should like to press upon the Stourbridge Council the advantage of taking over the whole of their fire appliances, because with voluntary subscriptions it is open to a certain amount of abuse. You do not know what your income is going to be and you have criticism over the expenditure; whereas, if the Council undertake it the ratepayers know what has been spent and have a right to grumble if the thing is not satisfactory. With a voluntary fire brigade you have not the same control over the plant nor have the ratepayers the same personal interest in the brigade. I should like to ask what the plant consists of; whether there is a motor or steamer, and what other appliances there are. Regarding the sewage farm, I notice it is let to a tenant, which is an unusual way of dealing with sewage. I should like to ask whether the tenant is responsible for the condition of the effluent, or whether it is worked by the Council, or a main drainage board; because if the farm is let to a tenant, and you have a particularly wet season and the man has crops, he naturally does not want to let the flood water ruin them. Therefore I should like to ask whether there is any agreement for compensation for flooding the farm in wet weather? As to Mr. Webb's paper, I am pleased that he has put down this tar-distilling plant, and I hope others will follow his example. The demand for tar is becoming greater year by year, and the

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cost of distilled tar is a heavy item in road maintenance, partly through heavy railway charges, which local district distilling plants would save. I do not think Mr. Webb can blame the surveyor's department alone for the condition of the barrels, because the railway companies are not too particular, and are just as liable to drop the barrels and damage them. I am supplying him now with some steel barrels, and they will stand some knocking about. I think it will be necessary in future to have steel barrels, because there is a good deal of leakage from the ordinary barrels after they have seen but very little service, a few journeys completing their effective life, so that in the long run steel barrels will prove more economical.

Mr. H. J. Coleby: I should like to know the rate at which the County Council contribute towards the maintenance of main roads. I must congratulate Mr. Woodward on the price of his tar painting with crude tar. I cannot do any tar spraying under 0·9 of a penny. That includes the binding with fine granite chips. I should like to know whether this 0·56 of a penny does include the cost of binding. With reference to the baths, it is stated that a loan was allowed for twenty-seven years for the building and five years for the water supply. I should like to know the reason for the short period for this loan; does it include the borehole, or only the necessary pump and machinery? With reference to the difference in the hardness of the two waters, I should like to ask what strata the upper part of the borehole was sunk into. I think the paper only states that the borehole was put down in the Bunter series. If that is the case all the way down, it seems curious that there should be a difference between the water drawn from the upper and lower part of the Bunter. I should like to ask whether any part of the bore was in a different formation like the Kuyper sandstone. If that is so, it may explain the difference in the hardness of the water. I should also like to ask the rate of bore, and whether Mr. Fiddian found any difficulty from loose pebbles or hard marl.

Mr. C. F. Gettings: I am particularly interested in the plant which Mr. Webb has put down in connection with treating tar. He should be commended for his enterprise. If many of my colleagues would confer with the gas engineers in their respective towns I think we should find them sufficiently progressive to give the matter their serious consideration, and, instead of allowing the distiller to make the profit, they will

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find it to their advantage to put down a plant and ask a reasonable price. If this is done, we shall get a good article at a lower price, and the demand will be greater. I know Mr. Webb's plant personally, and he has supplied my county with a considerable quantity of tar, from which we are getting excellent results. I see no reason why other towns should not do a similar thing. It seems ridiculous for gas departments of many towns to send crude tar fifty to a hundred miles simply to be treated and brought back again, with the result that a large proportion of the cost is taken up in railway carriage. Both the gas departments and the public authorities would benefit by setting up a dehydrating plant. I feel sure that gas engineers will recognise that there is a limit as regards price, and they will not force surveyors to seek other material to the exclusion of their own product.

MR. J. A. SPRECKLEY: The question of main roads is an interesting one just now, and I should like to have some further particulars with regard to the figures and the principle on which the Worcestershire County Council pay the Borough Council for the maintenance of their main roads.

THE PRESIDENT: I am sure you will be struck with the skill shown by Mr. Woodward in the design of the free library and secondary school. It is not often that the surveyor of an authority has the opportunity of designing public buildings of this nature, which must remain as a monument to his ability. Most of our work is deposited underground, and we do not have the opportunity of leaving it above ground to show what we can do. Stourbridge is to be congratulated upon being able to deal with their sewage in such an easy manner. The notes on the Stourbridge Gasworks are most interesting to all of us, and I agree with my friend Mr. Gettings that a great deal more could be done in this direction if the gas engineers and surveyors in our towns would consult together to secure similar results. We should then be able to obtain the material at a cheaper rate and do more work in this direction.

The vote of thanks to the Authors of papers was unanimously passed.

MR. F. WOODWARD, in reply: I thank you very much for the way you have received my paper. With regard to the low cost of road maintenance, especially on our by-roads, that is because we are using a rather cheap material, a local slag, and

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the bulk of our by-roads have very little traffic. The slag costs 3*s.* 6*d.* per ton at the wharf. It costs about 4*s.* 6*d.* on the road. With regard to the use of Rowley and Clee Hill stone, I have used both for the last twelve months, and have not had time to judge which is the best of the two stones; whether the Clee Hill is worth the extra money to the Rowley. It costs us about 1*s.* a ton more than the Rowley. It is supposed to make less mud and wear longer. We have always used on our main roads up to the last year or two Rowley stone practically because it is a local quarry and the traffic is not excessive. It is a very good metal. With regard to tar-painting and the advantages of using particular kinds of tar, my experience has been that the bituminous tar for tar-painting is not worth the extra money. It costs more to put on and during the season it has a better-looking surface, but in the autumn it is worn off or turned up into mud just the same as the ordinary crude tar, and as far as a dust preventive I think the refined or crude tar is equally as good as the bituminous, and at considerably less cost. With regard to the remarks on our destructor, I must say, from the steam point of view, we have been very disappointed with it. It is owing to several causes. The plant is so far away from the pumping-station, we lose considerably in condensation. We did have a superheater, but some of the tubes leaked so badly and continuously, and we had so much trouble with it, that I took it out a year or two ago, and it has not been put back. I have not found that we have done worse since. We have considered the question of doing away with steam blasts and having a fan, and I have thought, when we could afford it, we will go in for that system of forced draught. With regard to the baths, Mr. Pickering referred to the circulation of the water and the boiler. It is an ordinary circular type of boiler, not a sectional boiler, and is quite sufficient for its work. It is natural circulation. We pay 11*s.* 6*d.* per ton for our coal. Webb's ventilating lamp we find is perfectly satisfactory. We keep it partially alight during the day time, in fact we have had no complaints, and I think it perfectly satisfactory. The cost of our main roads has decreased during the last three years, since we commenced tar-painting them. The cost given, 1250*l.*, does not include the tar-painting or any works on the footpaths. It is simply for the maintenance of the carriage-ways. Then we have got pretty well all our main

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roads paved either with setts or wood. High Street is paved the full width of the carriage-way, and since that was done it has considerably relieved the cost of maintenance. Several of our main roads are narrow, and of course the double tracks take up most of the carriage-way, and we have only narrow margins. Gas-tar spraying constitutes all the dressing and is applied by one of Llewellyn and James's machines. The tar macadam plant has only just been completed, so I cannot say what quantity of tar we use. The cost of our street lighting is roughly 1500*l.* a year. As to our destructor wages, we pay a foreman 35*s.* a week, two men 27*s.* 6*d.*, and one man 25*s.* We work the two men on ten-hour shifts. I think we get on very well now with the County. We do not enter into any contract; we have not done so for years. We submit our accounts at the end of the year and make the best bargain we can. We get 1150*l.* from the County for ordinary maintenance, excluding the works. Up to this year the county contributed 50 per cent. of the cost of tar-painting, but in future we are to get 70 per cent. The loan for the baths includes the borehole and everything complete.

MR. W. FIDDIAN: I thank you very much for the way in which you have received my paper. Mr. Pickering asks how the plug was formed. A disc of wood was attached to the end of a boring rod, by a short connecting rod, having a left-hand screw joint (the ordinary joints being right hand), and lowered into position in the borehole. Small canvas bags, containing cement, were then dropped on to the plug, and these, in spreading, formed a layer connecting the plug to the sides of the borehole. When this cement layer was set, the boring rods were unscrewed at the left-hand joint, just above the plug, and withdrawn. A cylindrical vessel with sliding bottom was then fitted with cement grout, and lowered by a rope, until the stalk projecting from the bottom reached the plug, when the contents were discharged. This operation was repeated until the required depth of cement grout was obtained. Mr. Coleby asked some questions about the nature of the strata it passes through. The whole bore is in the Bunter series of the New Red Sandstone, and completely traverses the pebble beds. I cannot explain why it is that the upper part of the pebble bed gives so much harder water than the lower. That was one of the experiences which influenced me in deepening the borehole.

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In putting down the borehole, we found by tests that the water was almost exactly the same as we were getting from the Tack Station, where the bore is in the lower portion of the series. The rate of boring is shown on the diagram, and when printed with the paper will answer the question on that point. The paper refers to the difficulties experienced in going through the beds of pebbles. We had a thick bed of large pebbles, apparently quite loose, and the difficulty in dealing with them was very considerable. It was a question of time. We had to go on revolving the boring tool until the whole of the pebbles were ground away. With the conglomerate and other portions of the stone where there was no loosening, it was very interesting to see how easily they were got through. The rate was about 9 feet per day, except where the pebbles were met with. With regard to the sewage farm, I agree that it is a most unusual thing to find farms of this extent let to a tenant. But this experience has been quite satisfactory. We have now had the farm in existence for 28 years; in another two years we shall have paid off most of our loans; and during the whole of that 28 years, there has been no difficulty or complaint by the County Council or others, as to the condition in which we have discharged our effluent, or as to the way in which the farm has been managed. The responsibility for the effluent is put upon the tenant. He has a very strict agreement which requires him to distribute the sewage. He is given full control and is made responsible for the distribution and proper treatment of the sewage. I think the fact that we have gone on for 28 years without difficulty, speaks very well for the arrangement we have. But I should like to say we have, adjoining that farm, two other farms, making over 1000 acres, where the sewage is being dealt with by other tenants, and the whole is going on very satisfactorily. All these farms are under my supervision, and I have no reason to complain of the way in which the tenants carry out our requirements. In the last six months we have had 50 per cent. more rain than is usual, so it has been a very trying period for sewage treatment.

Mr. C. H. Webb—I am very much obliged to you for the kind way in which you have received my small contribution. The first point is as to the cost of the dehydrating plant. The particular variety of plant we have, is made in two sizes. We have the smaller size, equal to 1000 gallons of crude tar per

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twelve hours, or putting it in round figures, working day and night, it will turn out about 70 tons per week. The cost of this plant is slightly over 200*l.* To this has to be added whatever you require in the way of foundation. It is no good putting in a plant of this sort unless you have plenty of storage for the crude tar and the finished product. The total cost of the plant is between 300*l.* and 350*l.*, including all the work, with suction tanks and delivery tanks. With regard to the difference in the cost of crude tar, and the finished product, I have only had three or four months' experience with the plant, and do not know what the repairs will be; but I should say that, taking working expenses, interest, and sinking fund, a difference of 12*s.* 6*d.* or 15*s.* on the cost of common crude tar would be a fair figure. Crude tar is at present 30*s.*; that would mean from 42*s.* to 45*s.* for the finished article. I drew attention to the barreling of the tar, because that is a branch in which a good deal of money can be lost. I quite agree with Mr. Thorp that steel drums would be better; but I think tractors and trailers would be still more economical.

The Members proceeded to inspect the engineering works of Messrs. Jones and Attwood, and the oil gas plant and tar dehydration plant at Stourbridge Gas Works.

The Urban District Council kindly entertained the Members attending the Meeting to luncheon at the Talbot Hotel. The Chairman of the Council presided.

The afternoon was devoted to a trip on the Kinver Light Railway by kind invitation of the Dudley and District Tramway Company, an inspection of the Sewage Farm belonging to the Stourbridge and Upper Stour Valley Boards, the Public Baths, Free Library and Secondary Schools, Rocmac roads, and the tar macadam plant.

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THIRTY-NINTH ANNUAL MEETING.

LONDON, *July* 11, 12, *and* 13, 1912.

A. D. GREATOREX, M.INST.C.E. (PRESIDENT), *in the Chair.*

The Members assembled in the Caxton Hall, Westminster.

The Secretary read minutes of the Thirty-Eighth Annual General Meeting, which were confirmed and signed.

The Thirty-Ninth Annual Report was then taken. Its adoption was moved by the President and carried unanimously.

ANNUAL REPORT.

INTRODUCTION.

THE Council have pleasure in presenting the 39th Annual Report, recording the work of the year 1911–12.

NEW CONSTITUTION.

The last Annual Meeting saw the inauguration of the new Constitution, carrying in its train changes of great importance.

Districts.—The various districts into which the Institution is divided for administrative purposes have been altered to agree, practically, with those of the N.A.L.G.O.

Certain districts remain unchanged, but the Northern, Yorkshire, Lancashire and Cheshire, Midland, Eastern, Home and Western Districts have been recast to form new districts as shown :—

Name of New District.	District Chairman.	District Representatives.	District Secretary.
Scottish : (Vice-President) J. BRYCE.	J. BRYCE.	J. Young.	D. Ronald.

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Name of New District.	District Chairman.	District Representatives.	District Secretary.
Irish: (Vice-President) H. A. CUTLER.	W. COLLEN.	R. H. Dorman.	M. Sellars.
North Eastern: Comprising NORTHUMBERLAND, DURHAM, YORKSHIRE.	F. MASSIE.	E. B. Martin. E. R. Matthews.	J. P. Wakeford.
North Western: Comprising CUMBERLAND, WESTMORLAND, LANCASHIRE, CHESHIRE, ISLE OF MAN.	J. A. BRODIE.	J. S. Brodie. C. Brownridge.	A. W. Bradley.
East Midland: Comprising LINCOLNSHIRE, NOTTINGHAMSHIRE, DERBYSHIRE, LEICESTERSHIRE, RUTLAND.	E. G. MAWBEY.	E. P. Hooley.	R. A. MacBrair.
West Midland: Comprising STAFFORDSHIRE, SHROPSHIRE, HEREFORDSHIRE, WORCESTERSHIRE, WARWICKSHIRE.	A. T. DAVIS.	H. E. Stilgoe.	H. Richardson.
North Wales: Comprising ANGLESEY, FLINTSHIRE, DENBIGHSHIRE, CARNARVONSHIRE, MERIONETHSHIRE, MONTGOMERYSHIRE.	W. JONES.	J. P. Evans.	J. England.
South Wales: Comprising RADNORSHIRE, CARDIGANSHIRE, PEMBROKESHIRE, CARMARTHENSHIRE, BRECKNOCK, GLAMORGANSHIRE, MONMOUTHSHIRE.	W. HARPUR.	G. A. Phillips.	H. A. Clarke.
South Western: Comprising CORNWALL, DEVONSHIRE, SOMERSETSHIRE, DORSETSHIRE.	H. T. CHAPMAN.	T. Moulding.	T. Moulding.
Southern: Comprising GLOUCESTERSHIRE, OXFORDSHIRE, WILTSHIRE, BERKSHIRE, HAMPSHIRE, ISLE OF WIGHT, CHANNEL ISLES.	R. READ.	L. S. McKenzie.	F. R. Phipps.
South Eastern: Comprising SURREY, KENT, SUSSEX.	A. DRYLAND.	J. L. Redfern.	F. Roberts.

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Name of New District.	District Chairman.	District Representatives.	District Secretary.
Eastern: Comprising NORFOLK, CAMBRIDGESHIRE, HUNTINGDONSHIRE, NORTHAMPTONSHIRE, SUFFOLK, BUCKINGHAMSHIRE, BEDFORDSHIRE, HERTFORDSHIRE, ESSEX, and that portion of MIDDLESEX not comprised within the Metropolitan district.	A. FIDLER.	W. H. Prescott. H. T. Wakelam.	E. J. Elford.
Metropolitan: Comprising the area within which the Metropolis Management Acts are in force.	J. PATTEN BARBER.	N. Scorgie. O. E. Winter.	N. Scorgie.
India:	*H. LANE BROWN.	— *A. F. Henderson.	
Africa:	*W. INGHAM.	— *T. W. Stainthorpe.	
Abroad: Comprising members resident in places other than those included in the above districts.	—	—	—

The elections to the new district offices take effect as from the Annual Meeting at which this Report is presented, and the Council trust that the closer association with the general body of Members, which it is hoped will be established by the direct election of district representatives serving on the Council, will prove conducive to the best interests of the Institution.

DISTRICT EXECUTIVE COMMITTEES.

The by-laws provide for the election of an "Executive Committee" for each district, and the Council trust that these committees will be forthwith appointed.

DISTRICT MEETINGS.

During the year twelve District Meetings have been held:—At Handsworth, July 29; Gidea Park, September 22; Paignton, September 30; Battersea, October 21; Westminster, February 9; Exmouth, May 4; Nuneaton, May 11; Stirling, June 7 and 8; East Ham, June 15; Lowestoft, June 22; Bridlington, June 29; and Stourbridge, July 6.

* Appointed subsequently to the Annual Meeting.

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Visit to Paris.

A most interesting visit to Paris and its municipal works was paid at Whitsuntide, 1912, when about sixty of the members and their friends were most hospitably received by the authorities at the Hotel de Ville. The engineers of the various departments arranged a most instructive programme, and they spared no pains in explaining the several works and in giving every assistance in making the meeting an unqualified success.

Honorary Members.

In view of the great interest taken in the work of the Institution by the French engineers, the Council have elected the following gentlemen as Honorary Members of the Institution :— Mons. G. Bechmann, Mons. M. F. Bienvenue, Mons. Colmet-Daage, Mons. de Pontich, and Mons. M. P. Tur.

Special Meetings.

Special Meetings were held July 29, 1911, January 13, and February 9, 1912, in connection with the alterations to Memorandum and Articles desired by the Institution, and also those insisted upon by the Board of Trade. The Council trust to be able to report shortly that all statutory requirements have been complied with, and the Memorandum in its new form, removing the objectionable footnote to the Testamur, and widely extending the scope of the work of the Institution, is by the sanction of the Court, at last an accomplished fact.

The Roll of the Institution.

During the financial year ending April 30 last, 109 new Members, consisting of 34 Ordinary Members, 46 Associate Members, and 29 Students, have been elected. Twenty-eight resignations have been accepted and thirty names have been written off.

The names on the roll of (1) Associate Members, and (2) Associates and Graduates, on July 29, 1911, were respectively transferred (under the operation of Article 8) to the classes of (1) Members, and (2) Associate Members, and the roll now stands :—

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——	1906 to 1907	1907 to 1908	1908 to 1909	1909 to 1910	1910 to 1911	1911 to 1912
Hon. Members	9	9	8	8	8	1
Members	850	834	818	830	839	1028
Associate Members ..	—	39	78	114	128	243
Associates	144	123	127	137	131	—
Graduates	204	204	170	160	151	—
Students	—	—	—	—	—	29
Affiliated Members ..	—	—	—	—	—	47
Total	1207	1209	1201	1249	1257	1360

The Council record with regret the deaths of Mr. Lewis Angell (Past President), the founder of the Institution, and of Mr. J. T. Eayrs (Past President), also of Messrs. G. J. Bell, W. Diggle, G. Heaton, E. I. Lord, and T. H. Tarbit.

The Council desire to urge upon the younger members of the profession the importance of becoming attached to the Institution as students at as early an age as possible, and would ask the cordial co-operation of those members who have pupils or assistants upon their staffs, not connected with the Institution, to induce them to join.

The New Council.

Consequent upon the alteration in the constitution the number of ordinary members of Council has been reduced from fifteen to ten, and district representatives have taken the place on the Council hitherto held by the district secretaries.

The Scrutineers, having examined the ballot lists, report the following members elected as the Council for the year 1912–13.

President.—Mr. R. J. Thomas.

Vice-Presidents.—Messrs. J. W. Cookrill, T. W. A. Hayward, and J. S. Pickering.

Ordinary Members of Council.—Messrs. J. Patten Barber, J. A. Brodie, J. S. Brodie, A. H. Campbell, G. F. Carter, A. E. Collins, W. Harpur, W. T. Lancashire, H. P. Maybury, and C. F. Wike.

Hon. Secretary.—Chas. Jones.

Hon. Treasurer.—Sir James Lemon.

Serving upon the Council, in addition to these, are the

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District Vice-Presidents and District Representatives recorded earlier in this report.

The Finances.

The accounts which accompany this report for the financial year ending April 30, 1912, have been duly audited by the official auditors, Messrs. Wood, Drew & Co., and are presented with this Report. The fact that the year's working shows a slight deficit is accounted for by the heavy printing and lithography charges due to special expenditure on the Housing and Town Planning Conference Volume, and to abnormal expenditure in connection with the reconstitution of the Institution.

Having regard to the immense value of this Conference and the gain in the prestige of the Institution, as evinced by inquiries for the volume from all parts of the globe, the Council are satisfied that the money has been wisely spent. During the year 600*l.* has been invested in India 3½ per cent. stock.

Home Examinations.

During the year three examinations have been held, for which 86 candidates entered (75 presented themselves) for examination. Forty-three candidates satisfied the examiners, and have been granted the Testamur of the Institution. The Council would again press upon members the desirability of requiring the possession of the Testamur of the Institution, or an equivalent qualification granted by a recognised examining body, as a condition precedent to making appointments to their staffs.

Colonial Examinations.

An examination was held in Cape Town in April last, at which one candidate satisfied the examiners, and has been granted the Testamur of the Institution.

The long distances to be travelled by candidates, both in Africa and India, present considerable difficulty in making arrangements, but the Council trust that these will be overcome, and that this branch of the work of the Institution will be extended in the near future. Arrangements for the holding of an examination at Hong Kong are at present under consideration.

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Premiums.

The Council have awarded the following premiums for papers published in the last Volume of Proceedings :—

5*l.* 5*s.* to A. J. Price (graduate), for his paper, "Pumping Plant for Sewerage and Water Works."

4*l.* 4*s.* to W. Ransom, for his paper, "Filtration and Purification of Water for Public Supply."

3*l.* 3*s.* to F. G. Holmes, for his paper, "The Main Drainage and other Municipal Works at Govan."

3*l.* 3*s.* to C. G. Mason, for his paper, "Municipal Progress in Guildford."

For papers read at the Housing and Town Planning Conference the Council awarded Institution premiums as follows :—

3*l.* 3*s.*, to T. Wallis Gordon, for "Town Planning as applied to Suburban Areas."

2*l.* 2*s.*, to W. Wainwright, for "The Municipal Engineer and Town Planning."

2*l.* 2*s.*, to E. A. Slater, for "The Planning of an Industrial Suburb."

President's Prize.

The prize offered by Mr. A. D. Greatorex (President) for the best paper read by a student at the Annual Meeting has been awarded to Mr. W. H. Price for his paper on "Town Planning," to be read at this forthcoming Annual General Meeting.

Affiliation of the Scottish Road Surveyors' Association.

The Council record with pleasure the completion of the affiliation of this Association with the Institution, resulting in an accession of fifty-three affiliated members. Six of these gentlemen have been elected, at their request, to full membership.

Admission of Visitors.

The Council have revised the regulations for the admission of visitors to the meetings of the Institution, and the new arrangements appear to be giving general satisfaction.

New Offices.

Continuous efforts have been made during the past year to find more adequate and suitable premises for the increasing work

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of the Institution and for the holding of the numerous council, committee, and other meetings, but, up till now, without success.

The new Council will, therefore, take up this task as one of the urgent matters requiring their attention.

Arbitration Clause.

The Council received a request from the National Federation of Building Trades Employers and referred the consideration of a clause relating to arbitration in engineering contracts, to a committee. After very full discussion, the Council, on the recommendation of the Committee, have informed the Federation † that they are prepared to recommend that the Members of the Institution adopt the form of clause set out hereunder in lieu of the usual clause appointing the Engineer to the authority the sole Arbitrator in cases of dispute with a contractor:—

Arbitration.

In case any dispute or difference shall arise between the Council, or the Engineer on their behalf, and the Contractor, either during the progress of the works or after the determination, abandonment, or breach of the contract, as to the construction of the contract, or as to any matter or thing arising thereunder, (except as to the matters referred to in the undermentioned clauses "*a* to . . . ", all which shall be left to the sole discretion or decision of the Engineer, viz.:—

* (*a*) As to the provision of everything necessary for the proper execution of the works, etc.

* (*b*) As to the amendment of errors arising from inaccurate setting out of works.

* (*c*) As to the quality of materials and workmanship.

* (*d*) As to the competency of the general foreman on the works.

* (*e*) As to the competency or conduct of any person employed on the works by the contractor.

* These are intended as illustrations of the matters which engineers may wish to deal with themselves, or may wish their Councils to deal with, instead of allowing them to be submitted to arbitration. Each engineer can insert in this part of the clause whatever matters he desires to exclude from arbitration.

† Further representations from the Federation have since been received and are under consideration. [Ed.]

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*(*f*) As to the measurement and valuation of extra work and variations, or the mode of ascertaining the amount to be allowed for extra work and variations.

*(*g*) As to the rejection and removal of work and materials not in accordance with the specification or the instructions of the engineer, and the substitution of other work and materials therefor, and all other matters referred to in this clause.

*(*h*) As to defects or faults which may appear in the works after completion.

*(*i*) As to the opening of work for inspection.

*(*j*) As to the date when the works are completed.

*(*k*) As to the execution of works having been delayed by inclement weather and other causes.

*(*l*) As to the carrying on of the works with dûe diligence, etc., etc.

*(*m*) As to the expenditure of provisional sums.

*(*n*) As to the issuing of certificates relating to payments to the contractor.

Also, except as to the matters referred to in the under-mentioned clauses numbered "A to . . . ", all which shall be left to the sole discretion or decision of the Council:—

*(A) As to the assignment or sub-letting of any portion of the works.

*(B) As to the determination of the contract by the Council,) or as to the withholding by the engineer of any certificate to which the contractor may claim to be entitled, either party shall forthwith give to the other written notice of such dispute or difference, and such dispute or difference shall be and is hereby referred to the arbitration and final decision of a person to be appointed, on the request of either party, by the President for the time being of the Institution of Municipal and County Engineers, and the award of such arbitration shall be final and binding upon the parties. Such reference, except of the question of certificate, shall not be opened until after the completion, or alleged completion, of the works, unless with the written consent of the Council, or the Engineer, and the Contractor. The arbitrator shall have power to open up, review, and revise any certificate, opinion, decision, requisition, or notice, save in regard to the said matters expressly excepted above, and to determine all matters in dispute which shall be submitted to him, and of

* See notes preceding page.

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which notice shall have been given as aforesaid, in the same manner as if no such certificate, opinion, decision, requisition, or notice had been given. Upon every, or any such reference, the cost of and incidental to the reference and award respectively shall be in the discretion of the Arbitrator, who may determine the amount thereof, or direct the same to be taxed as between solicitor and client, or as between party and party, and shall direct by whom and to whom and in what manner the same shall be borne and paid. This submission shall be deemed to be a submission to arbitration within the meaning of the Arbitration Act, 1899:

Provided always that this clause shall not apply to any contract, the total original amount, sum, or value of which, exclusive of any extras or additions, is less than one thousand pounds (1000*l.*), or to any differences or disputes which in connection with any one contract shall involve a total amount, sum, or value of less than fifty pounds (50*l.*), in either of which two events all matters arising out of the contract and any difference or dispute shall be in the sole judgment and discretion of the Engineer, whose decision shall be final and binding on all parties and without appeal.

Priced Schedules with Tenders.

The same Federation drew the attention of the Council to the practice of many engineers to local authorities requiring that priced bills of quantities and schedules should accompany tenders. The Council passed the following resolution, and recommend the same for adoption by the Members:—

"That it is not necessary, nor is it desirable, that priced bills of quantities and schedules should be sent in openly with the tenders; but that it is essential that the prices in the bill of quantities and schedule should be approved by the engineer before a tender is recommended for acceptance."

Housing and Town Planning Conference.

The Council record with gratification the great success of the Conference held at West Bromwich in connection with the last Annual Meeting, when nearly two hundred delegates were appointed by their respective authorities to attend.

Seventeen papers dealing with the subject in all its aspects

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were read and discussed, and were subsequently printed, together with the discussions, in a volume published by Messrs. E. & F. N. Spon, Ltd., 57 Haymarket, price 10*s.* 6*d.* Copies may still be obtained, but the edition is being rapidly exhausted.

The papers were profusely illustrated and numerous reproductions of the plans kindly lent by various authorities and others, and exhibited during the Conference, were also included in the volume.

Unfortunately the engagements of the Right Hon. John Burns, President of the Local Government Board, prevented his attendance, but in a letter subsequently written to the Secretary he conveyed his hearty congratulations to the Institution upon the valuable addition afforded by the volume to the literature upon this important subject.

The Council have received an invitation from the R.I.B.A. to appoint delegates to a conference to be held in the near future to consider the necessity for the co-ordination of town planning schemes. The Council have delegated Messrs. John A. Brodie, J. W. Cockrill, and H. E. Stilgoe to represent the Institution at this conference.

Honours to Members.

The Council record with gratification that the honour of Knighthood has been bestowed on one of the members of the Institution, Sir Maurice Fitzmaurice, C.M.G., and that a Past President, Mr. John A. Brodie, has been chosen to advise the authorities in the town planning of Delhi, the new capital of India.

Engineering Appointments Board.

The Council desire to draw the attention of the members to the Appointments Board recently formed by the Institution of Civil Engineers. This Board, for a nominal fee, will endeavour to bring those requiring engineering assistants and those qualified to fill the position into contact. At the same time the Council would remind members that the services of the official staff of this Institution are always at their disposal in this direction.

Mutual Defence Fund and the Case of Mr. W. Jones (Colwyn Bay) *v.* Frost.

The Council referred this particularly hard case, in which the plaintiff was compelled to bring an action to vindicate his

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character, to their solicitor, Mr. A. M. Bramall. Mr. Jones achieved complete success, being awarded heavy damages and his costs, but unfortunately, the defendant proved to be utterly without means, and Mr. Jones has been unable to recover either damages or costs, the latter amounting to some 240*l.*

Mr. Bramall advised the Council that, although legal assistance might have been provided out of the funds, had application been made to the Council for such assistance, the memorandum clearly prohibited the payment of any sum of money to recoup Mr. Jones.

Hitherto the power to assist members, by the provision of legal advice, contained in the Memorandum, has been relied upon, but with the increased scope of the Memorandum as it now stands, the Council feel that a Defence Fund has become an urgent necessity. On the motion of Mr. A. D. Greatorex (President), the Council recently referred the matter to the chairmen of their Standing Committees, and it is to be hoped that a scheme will shortly be placed before the members for their approval and adoption.

In the meantime the Council have started the mutual Defence Fund with donations amounting to some 30*l.*, and a circular letter, appealing for immediate support, accompanies this Report. Direct financial assistance from the funds of the Institution being prohibited by the Memorandum of Association as aforesaid, the Council have already assisted out of the Defence Fund, and trust that a cordial response from the members will enable them further to assist, the hard case above referred to, and to place the Fund on a working basis.

Standardisation Committee.

This Committee has held numerous meetings during the past year, and has had under consideration a number of matters relating to standardisation, the more important being the following:—

Concrete Flags.—The standard specification has been completed and published at 2*s.* 6*d.* per copy. It has met with a ready sale, and the first edition is being rapidly disposed of.

Vitrified Pipes.—See *Delegates' Reports.*

Period of Loans for Wood Paving.—This question has also been under the consideration of the Committee, and they have now received an intimation from the L.G.B. that, as a general rule,

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the period for repayment of loans for creosoted soft woods will be the same as for hard woods, viz. ten years, the period for uncreosoted soft woods being five years.

Roads Committee.

The Council's attention having been called by the Cyclists' Touring Club to the damage caused to road surfaces by studded tyres, a reply was sent that the Council had already endeavoured to obtain an amendment to the law relating to this subject, and will continue to press the importance of the matter upon the L.G.B. The Council have given careful attention to the urgent necessity of amendments to the Highways and Locomotives Act, 1878, and the Heavy Motor Car Order, 1904, and have made strong representations to the Local Government Board accordingly. The Council have also considered suggestions as to caution symbols, and have forwarded their recommendations to the County Councils' Association. A resolution passed by the Lower Thames Valley District Surveyors' Association, as to further powers being conferred upon local authorities to define the routes of heavy motor traffic, was received. After careful consideration the Council found themselves unable to agree with the suggestion that local authorities should have conferred upon them the power to define routes for such traffic.

Delegates.

The following gentlemen have been appointed to serve the Institution as delegates to other bodies:—

Messrs. Charles Jones, Hon. Secretary to the Sanitary Inspectors' Examination Board.

„ A. D. Greatorex and N. Scorgie to the N.A.L.G.O.

„ E. B. B. Newton to the Plumbers' Registration Committee.

„ W. Harpur and C. F. Wike to the Engineering Standards Committee (Tramway Rails).

„ J. Patten Barber, E. J. Elford, and F. W. Pearce to the Engineering Standards Committee (Vitrified Ware Pipes).

„ E. J. Elford and R. J. Thomas to Engineering Standards Committee (Conference on Road Materials).

„ A. D. Greatorex and J. Walker Smith to the Royal Sanitary Institute Congress.

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Messrs. E. Purnell Hooley to the Central Committee on Road Statistics.

„ E. Purnell Hooley, H. P. Maybury, and R. J. Thomas to Central Committee on Road Statistics (Conference on Highways and Bridges Act).

„ G. F. Carter, E. J. Elford, T. W. A. Hayward, E. B. B. Newton, and N. Scorgie to the Institution of Electrical Engineers (Joint Conference on Street Lighting).

„ A. D. Greatorex, E. P. Hooley, A. T. Davis, H. P. Maybury, and R. J. Thomas to the General Committee, International Roads Congress, 1913.

„ E. J. Elford, A. D. Greatorex to Engineering Standards Committee (Cast-iron Pipes).

Reports from Delegates.

Mr. N. Scorgie: *National Association of Local Government Officers.*—During the past year meetings of the National Council have been held in London and at Leamington, and the membership roll since the last report has increased by nearly seven thousand.

The activities have been great during the past twelve months, one of the most notable accomplishments being the inauguration of an extensive scheme of examination for the clerks of the various departments of a local authority. This scheme has met with universal approval by the progressive young men engaged in local government administration, and will meet a long felt want by those officers who have never before had an opportunity of securing a diploma of efficiency in their particular kind of work. There is not any intention by the N.A.L.G.O. of competing with existing examinations conducted by professional associations, and every precaution has been taken to avoid overlapping.

In the surveyors' section, the professional side is not touched, but an examination for clerks in engineer and surveyors' departments is held. The syllabus for this department is wide, and any clerk desirous of passing the examination will have to be well versed in the general routine and organisation of a surveyor's department, and be possessed of a good knowledge of the law relating to our work. Anything which tends to improve the efficiency of the municipal clerk should be grasped by both hands.

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The launching of the N.A.L.G.O. examination scheme will be a decided help to the engineers and surveyors of the service since it helps to make more proficient their clerical staffs.

The Benevolent and Orphans' Fund which only came into real existence about twelve months ago is making rapid strides. During the past year several cases of distress have been taken in hand. It is confidently anticipated that by the end of the Association's current year—September next—several hundreds of pounds will have been accumulated. With such an extensive membership as the N.A.L.G.O., and given proper support, it should be possible for this fund to meet all cases of distress that may occur in the local government service. The ideal being aimed at by the National Association is a high one, and it is quite within the bounds of possibility that its scope of usefulness will overtake that of the N.U.T. and other great institutions.

The superannuation question is the one no doubt nearest to our hearts, and no one can say that the N.A.L.G.O. is lacking in efforts to bring about legislation embodying a system of deferred pay for municipal officers. It is, however, a problem pregnant with difficulties, one of the greatest of which is to educate our employers—the authorities—to realise that the officers will not benefit alone by a proper scheme of national superannuation. The primary object, and ultimate effect, of a national superannuation scheme, is efficiency. It is no rash statement to say that a contented municipal officer is a valuable asset, and to be relieved of the worry of making provision for the evening of our careers would allow most of us to give our best to the service with a feeling of contentment. The policy of the National Association is not to rush hazardously to Parliament and demand superannuation, but to petition the Government and the local authorities, through their organisations, with a view to an all-round appeal being made for treating the local government officer like other public servants as regards superannuation. In this direction, rapid strides have been made. The N.A.L.G.O. has been successful in enlisting the sympathy of the County Councils' Association, the Urban District Councils' Association, and is now in negotiation with the Association of Municipal Corporations, which important body it is hoped will make a favourable report in the near future. It is much better to meet any opposition before going to St. Stephen's than after entering the House of Commons, and the N.A.L.G.O.

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is to be complimented upon, and encouraged in, furthering the safe policy which it has adopted on this important matter.

Security of tenure of office is another subject which interests the municipal engineer, and it will no doubt be a source of satisfaction that the N.A.L.G.O. superannuation includes a clause to ensure the security of tenure of the office of the local government officer.

The interests of the local government officer have been closely watched with regard to the National Insurance Act. A special committee has been sitting for many months past, and has made periodical reports to the federated branches, repeatedly making suggestions as to the line of action which they should take up. An Approved Society has been formed through which the officers will get better benefits than any other society can offer in return for the minimum total contributions of employer and employee of 7*d*. per week. This step is one of paramount importance to local government officers, and will, no doubt, be supported by thousands.

The N.A.L.G.O. has applied for a Royal Charter of Incorporation, and is now awaiting the decision of the Privy Council.

The foregoing report deals chiefly with what might be termed the "large" objects of the Association; but the work and influence of the N.A.L.G.O. is by no means confined to those matters. The question of altering the Treasury's ruling on compensation on abolition of office has received careful attention during the past year, and the efforts of the N.A.L.G.O. will no doubt bring about some improvement. Assistance has been given to the Irish officials in their efforts to include safeguards in the Home Rule Bill. The Association has also been of great assistance to a large number of officers in tendering legal advice on matters affecting their status, and this year a large proportion of the Association's income has been earmarked for law and parliamentary purposes.

MR. W. HARPUR: Your representatives on the Engineering Standards Sub-Committee on Tramway Rails have to report that little work has been done in connection with standardisation during the past year, their work having practically ceased when the standards were agreed to by the main committee.

There have, however, during the year, been several additions made to the committee, and, in consequence, there have been proposals for certain alterations in the standard sections of rails.

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Nothing, however, has been definitely decided upon these matters, which are still under consideration.

Recently further additions to the Tramway Rails Sub-Committee have been made by the appointment of two additional representatives each from The Light Railways and Tramways Association and The Municipal Tramways Association.

As a consequence, your tramways committee have asked for similar increased representations on the sub-committee, and the matter is to come before the main committee at an early date.

MR. E. J. ELFORD: *Vitrified Ware Sewer and Drain Pipes.*—The draft specification prepared by your Standards Committee has been referred to the Engineering Standards Committee, and is now being dealt with by a sectional committee, comprising engineers, architects, manufacturers, and representatives of Government departments. The various clauses of the draft have been discussed at considerable length, and a number of points have been agreed. The representatives of this Institution have reported from time to time to the Standardisation Committee, and various modifications have been agreed to.

Cast-iron Pipes.—The Committee have drafted a specification, which has been printed and circulated.

MR. R. J. THOMAS: Your delegates attended a conference called by the Engineering Standards Committee to consider whether the standardisation of road material is desirable.

It was resolved that such standardisation was desirable, and that the Main Engineering Standards Committee be recommended to form a Sectional Committee to deal with the matter.

MR. T. W. A. HAYWARD: The Council last year were invited to send five representatives to a conference to take into consideration the preparation and issue of a standard specification for street lighting. The Council, on the recommendation of the Standardisation Committee, appointed the following as their representatives:—Messrs. G. F. Carter, E. J. Elford, T. W. A. Hayward, E. B. B. Newton, and N. Scorgie.

Thirteen meetings have been held, the attendances of your representatives being as follows:—Mr. E. J. Elford, 12; Mr. T. W. A. Hayward, 12; Mr. E. B. B. Newton, 11; Mr. G. F. Carter, 9; Mr. N. Scorgie, 8. The draft specification has been prepared, and will in the near future receive the consideration of the Council of the Institution. It is hoped that the specification may be issued at no distant date.

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MR. E. PURNELL HOOLEY: The question of systematically dealing with direction posts and danger signals has again been the chief question before the committee, as the committee's previous recommendations were again amended by the County Councils' Association. A difficulty in getting sufficient members to attend on any one day has been experienced, and the committee has been asked to accept the name of a second representative of this Institution.

MR. R. J. THOMAS: *International Roads Congress.*—Messrs. A. D. Greatorex, E. P. Hooley, H. P. Maybury, and R. J. Thomas, representing the Institution upon the General Committee of the International Roads Congress, 1913, attended the meeting of the General Committee, when sub-committees were elected to deal with each question set forth in the official programme. It is satisfactory to note that the Institution is represented by a large number of members upon these sub-committees. Several meetings have been held, the course generally adopted being to invite observations and opinions on each question from those conversant with, and experienced in, the branch of road work referred to. Each Committee will consider the views set forth in these communications, and prepare for the Congress a report indicating the generally-accepted practice in this kingdom relative to the question under review.

MR. CHARLES JONES (Hon. Secretary): The work in connection with the Sanitary Inspectors' Examination Board is carried out in a very satisfactory manner, and the examinations give evidence of a higher degree of proficiency year by year. These examinations were held in 1911, two in London, and one in Birmingham, the total number passed was 56, viz. Males, 27; Females, 29.

CONCLUSION.

In conclusion, your Council feel, in a review of the proceedings which have occupied the attention of the various Committees and the Council at large, that they have much reason to congratulate the Members upon the satisfactory results of the year. There has been no more critical year in the history of the Institution. Subjects upon which much difference of opinion existed have been satisfactorily arranged, and new departures have been inaugurated which, your Council feel assured, will tend still further to strengthen the bonds

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of union which in the past have tended so materially to the best interests of the Institution in which we are all so deeply interested.

CHARLES JONES,
General Hon. Secretary.
THOMAS COLE,
Secretary.

11 VICTORIA STREET,
WESTMINSTER, S.W.

The President then presented the President's Prize and the Institution premiums awarded for the best papers read at meetings of the Institution during the past year.

Messrs. Wood, Drew & Co. were re-elected auditors, and their remuneration fixed at fifteen guineas.

The following were elected scrutineers: Messrs. R. J. Angel, C. J. Dawson, F. Harris, T. Henry, P. G. Killick, W. F. Loveday, A. E. Prescott, and W. B. Purser.

It was resolved that in the event of any member elected a scrutineer becoming a candidate for office, he should be disqualified from acting as scrutineer.

Mr. Greatorex then introduced his successor, Mr. R. J. Thomas, and vacated the chair in his favour.

Mr. J. S. Brodie moved, Mr. Harpur seconded, "That the best thanks of this meeting be given to Mr. Greatorex, for his management of the affairs of the Institution during the past year." This was supported by Sir James Lemon, and Mr. C. Jones, and carried unanimously.

Mr. Greatorex duly acknowledged the vote.

A very pleasing little ceremony took place, in the presentation by the Council of a silver cradle to Mrs. Greatorex, to mark the interesting event of the birth of a daughter during Mr. Greatorex's year of office as President. Mr. Thomas made the presentation in happily chosen words, and Mr. Greatorex replied in warm acknowledgment. The cradle was passed round for inspection, and received contributions amounting to 10*l.* 15*s.* for the Orphan Fund.

[NOTE.—The Presidential Address of Mr. R. J. Thomas, together with the papers read at the 39th Annual Meeting, and at District Meetings held during 1912–1913, will be reported in Volume XXXIX of the "Proceedings of the Institution."—ED.]

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Dr. INCOME AND EXPENDITURE ACCOUNT

EXPENDITURE.	£ s. d.	£ s. d.
To Reports of Meetings	..	50 8 0
„ Examiners' Fees and Expenses	..	102 5 10
„ Printing, Lithography, and Stationery (including Postage)	..	792 14 8
„ „ on New Constitution	..	64 0 3
„ „ Conference Volume	..	278 17 8
„ Expenses of Meetings	..	92 15 5
„ Rent of Office and Coals	..	79 5 8
„ Bankers' Charges	..	0 8 2
„ Telegraphic Address and Telephone	..	10 16 0
„ Expenses of Delegates and Affiliation	..	15 1 7
„ Premiums	..	31 4 3
„ Law Reports and Parliamentary Papers	..	10 7 6
„ Salaries	..	601 0 4
„ Office Expenses	..	62 14 0
„ Petty Cash—		
Postage	..	44 6 6
General	..	11 0 0
„ Legal Charges	..	24 9 6
„ Audit Fee	..	10 10 0
„ Amounts written off—		
Subscriptions	52 1 0	
Investments	61 10 11	
Office Furniture	11 12 0	
		125 3 11
	£	2407 9 3

Dr. BALANCE-SHEET ON

LIABILITIES.	£ s. d.	£ s. d.
To Sundry Creditors	..	194 1 8
„ Premiums in respect of Volume XXXVII.	..	15 15 0
„ Subscriptions in advance	..	32 18 6
		242 15 2
„ Accumulated Fund—		
Balance at April 30, 1911	2419 10 2	
Less Deficiency for year ending April 30, 1912 ..	24 3 6	
		2395 6 8

Report to the Members of the Institution of Municipal and County Engineers.

In accordance with the provisions of section 113 of the Companies (Consolidation) Act, 1908, we report that we have examined the above Income and Expenditure Account and Balance Sheet with the books and vouchers and have obtained all the information and explanations we have required. The Balance Sheet in our opinion is properly drawn up so as to exhibit a true and correct view of the state of the Institution's affairs according to the best of our information and the explanations given to us, and as shown by the books.

WOOD, DREW & CO. (Chartered Accountants), Auditors to the Institution.
6 & 7 Queen Street, Cheapside, London.
June 22, 1912.

£2638 1 10

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FOR THE YEAR ENDING APRIL 30, 1912. Cr.

INCOME.	£ s. d.	£ s. d.
By Subscriptions	..	1795 9 6
„ Entrance Fees	..	66 5 6
„ Examination Fees	..	258 6 0
„ Delegates Fees	..	64 1 0
„ Sale of Proceedings	..	123 10 9
„ Interest on Investments and on Deposit	..	75 13 0
„ Deficiency for Year carried to Accumulated Fund ..	..	24 3 6
	£	2407 9 3

APRIL 30, 1912. Cr.

ASSETS.	£ s. d.	£ s. d.
By Cash—		
at Bank	85 19 2	
in Hand	9 9 8	
		95 8 10
„ Investments—		
£190 Southampton Corporation 3½ % Stock at 94	178 12 0	
£553 2s. 9d. India 2½ % Stock at 66⅓	367 16 9	
£650 0s. 3d. London County 2½ % Stock at 71 ..	461 10 2	
£200 Metropolitan 2½ % Consolidated Stock at 77½	155 0 0	
£407 11s. 9d. New South Wales 3½ % Stock at 97½	397 7 11	
£600 India 3½ % Stock at 93	558 0 0	
		2118 6 10
„ Subscriptions in Arrear	370 0 6	
Less Reserve	150 0 0	
		220 0 6
„ Amount due for Sale of Proceedings	..	23 16 8
„ Stock of Proceedings—estimated value	..	100 0 0
„ Office Furniture	..	80 9 0
	£	2638 1 10

A. D. Greatorex (*President*).
James Lemon (*Hon. Treasurer*).
Charles Jones (*Hon. Secretary*).
Thomas Cole (*Secretary*).

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APPENDIX.

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STATISTICAL RETURNS

On the following subjects lie at the Offices of the Institution, 11 Victoria Street, Westminster, S.W. Those marked thus * are in duplicate, and can be borrowed for perusal by Members on application to the Secretary. Those *not* marked * can only be inspected at the Offices.

N.B.—Please quote Reference Number when applying for Loan of Returns.

(Members are requested, when kindly sending statistics, to do so in duplicate if possible.)

Ref. No.	
	Abattoirs (Public).
12	*W. Chapple Eddowes. 1902.
	Cemeteries (Public).
53	H. Richardson. 1904.
	Drainage Connections (Private).
11	*H. Richardson. 1902.
	Drainage (House).
1	J. Atkinson. 1894.
	Drainage (New Buildings).
49	*E. J. Lovegrove. 1896.
	Fire Brigades.
36	G. T. Lynam. 1899.
67	*H. W. Longdin. 1907.
	Hospital (Infectious Diseases).
59	*J. Walker Smith. 1905.
	Labour, Conditions of.
63	*A. E. Collins. 1906.
	Lighting (Electric).
3	J. W. Brown. 1894.
4	J. W. Cockrill. 1891.

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Ref. No.	
	LIGHTING (ELECTRIC).
5	W. A. Davies. 1893.
40	E. J. Silcock. 1896.
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6	J. W. Bradley. 1895.
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9	C. C. Smith. 1892.
8	A. H. Campbell. 1895.
48	*E. J. Lovegrove. 1900.
54	*A. E. Nichols. 1903.
68	*C. Chambers Smith. 1908.
70	*F. C. Cook. 1907.
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69	*G. W. Warr. 1908.
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38	*G. T. Lynam. 1899.
	MOTOR WAGONS (UTILITY AND WORKING OF).
57	*J. Walker Smith. 1905.
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10	C. F. Wike. 1890.
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46	A. E. Collins. 1896.
47	J. Hall. 1896.
41	E. A. Stickland. 1897.
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13	W. J. Newton. 1892.
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42	*P. Edinger. 1897.
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14	J. Price. 1891.
2	*A. E. Nichols. 1906.
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71	H. Clegg. 1905.
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15	W. Brooke. 1885.
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16	J. Price. 1896.
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17	C. R. Fortune. 1886.
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18	W. Howard-Smith. 1894.
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31	H. Richardson. 1899.
	ROADS (PREVENTION OF DUST).
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19	A. W. Parry. 1885.
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20	W. Dawson. 1891.
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25	J. W. Cockrill. 1885.
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34	Town Clerk of Birmingham. 1899.
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28	J. T. Eayrs. 1890.
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EXAMINATIONS.

SYLLABUS.

The Institution of Municipal and County Engineers undertake the holding of Examinations, by written papers and *viva voce*, in the following subjects:—

Engineering as applied to Municipal work. (Two papers.)
Building Construction and Materials.
Sanitary Science as applied to Towns and Buildings.
Municipal and Local Government Law as relating to the work of Municipal Engineers and Surveyors.

Every candidate who applies for permission to sit for the Examination of the Institution must be at least 22 years of age, and must possess one of the Certificates hereinafter mentioned in each of the following subjects:—

English, including (1) English Composition; (2) English Grammar, including Analysis and Parsing; (3) English History; (4) Geography.

Mathematics, including (1) *Arithmetic*—Vulgar and decimal fractions, proportion, square root, simple and compound interest, profit and loss, percentage, H.C.F. and L.C.M.; (2) *Algebra*—the ordinary rules; fractions; brackets; simple, simultaneous and easy quadratic equations, and problems involving the use of such equations; H.C.F.; L.C.M.; and square root; (3) *Euclid*—the first three books.

List of Certificates which will be accepted as evidence that Candidates possess the necessary qualifications in the various subjects:—

(1) English Composition and (2) English Grammar.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.

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University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "English Composition," "English Language," and "English Literature."

Oxford Local:
Senior Examination—Honours or Pass.
Junior Examination—Honours or Pass.
Cambridge Local:
Senior Examination—Honours or Pass.
Junior Examination—Honours or Pass.
} Certificate for English Language and Literature will be accepted as qualification required in English Composition and English Grammar.

Society of Arts: Advanced stage—First or Second Class, obtained since 1904; Intermediate stage—First Class, obtained since 1904; and the certificates corresponding thereto obtained prior to 1904.
College of Preceptors: First Class (or Senior), Second Class (or Junior), in the Professional Preliminary Examination; First Class (or Senior), Second Class (or Junior), in Certificate Examination.

(3) English History.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.

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Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar. Certificate for History will be accepted as qualification required in English History.
Cambridge Local: As for English Composition and English Grammar. Certificate (Senior or Junior) for History, Geography, etc., will be accepted as qualification required in English History and Geography.
Society of Arts: As for English Composition and English Grammar. Certificate for Commercial History and Geography will be accepted as qualification required in English History and Geography.
College of Preceptors: As for English Composition and English Grammar.

(4) GEOGRAPHY.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.
University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior.
Oxford Local: As for English Composition and English Grammar.
Cambridge Local: As for English History.
Society of Arts: As for English History.
College of Preceptors: As for English Composition and English Grammar.

MATHEMATICS.

University of London: Matriculation Examination.
Victoria University: Preliminary Examination.
University of St. Andrews: Preliminary Examination in Science.
University of Glasgow: Preliminary Examination in Science.
University of Aberdeen: Preliminary Examination in Science.
University of Edinburgh: Preliminary Examination in Science.
University of Dublin: General Examination at end of Senior Freshman year.
University of Wales: Matriculation Examination.
University of Birmingham: Matriculation Examination.
King's College, London: Examination for the College Matriculation Certificate in Engineering.

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University College, London: Matriculation Examination (Engineering Department).
Royal Indian Engineering College, Cooper's Hill: Entrance Examination.
City and Guilds of London Central Technical College: Matriculation Examination.
University College, Bristol: Preliminary Examination (Engineering Department).
Scotch Education Department: The Leaving Certificate.
Oxford and Cambridge Schools Examination Board: A Higher Certificate.
University of Adelaide: Senior Public Examination.
University of Tasmania: Senior Public Examination.
Central Welsh Board: Honours, Senior or Junior. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
Oxford Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
Cambridge Local: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic" and "Mathematics."
College of Preceptors: As for English Composition and English Grammar. Certificate to be endorsed "Arithmetic," "Algebra," and "Geometry."
Board of Education: Science Examination—Stage 1, First Class; or Stages 2 and 3, any Class.

A Candidate who has been admitted to any of the undermentioned examinations is exempt from further educational examination: The Institution of Civil Engineers, Studentship; The Royal Institute of British Architects, Preliminary; the Surveyors' Institution, Preliminary.

The Council reserve power to alter or add to the foregoing requirements.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council and duly advertised beforehand.

Examinations will also be held in Scotland and Ireland, and in India and South Africa, providing a sufficient number of Candidates desire to enter. Inquiries as to the respective Colonial Examinations should be addressed to A. F. Henderson, Municipal Engineer, Chittagong, Eastern Bengal; or T. W. Stainthorpe, P.W.D., 55 Parliament Street, Cape Town, South Africa.

Candidates must in the first place apply to the Council, on the form issued with the syllabus, for "permission to sit."

If permission is granted by the Council, a "sitting" form will be forwarded. The candidate may then, or at any time subsequently, make application on such form to be entered for examination.

The Council will accept entries, in order of priority, as far as accommodation will permit.

The fee for home Examinations is 4*l.* 4*s.*, two guineas to be paid when sending in the "sitting" form, and two guineas on the day of examination.

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The fee for Colonial Examinations is 4*l.* 4*s.*, to be paid when sending in the "sitting" form.

The fee is to be sent with the sitting form ONLY.

Candidates who do not present themselves for examination forfeit their entrance fee.

Successful candidates receive a "Testamur," signed by the acting Examiners, and sealed and counter-signed by the President and Secretary of the Institution in Council.

A candidate sitting for examination and failing to satisfy the examiners in not more than two of the five subjects, will be permitted to sit at any subsequent examination, on payment of half-fees, for re-examination in the subject or subjects in which he failed. Upon completing his passes in all the five subjects, he will be duly granted the testamur of the Institution.

A candidate failing in more than two subjects will be permitted to sit, for re-examination in all the subjects, at any subsequent examination, on payment of half-fees.

Candidates who have sat and failed, are particularly requested to ask for a "sitting" form, when they desire to enter their names for re-examination.

Candidates who have been relegated in one or two subjects should apply for a "relegated candidate's sitting form" when they desire to enter their names for re-examination.

The Examinations occupy three days, and the subjects are taken as follows:—

First day,	10 to 1 ..	..	Sanitary Science.
„	2.30 to 6.30	..	Building Construction.
Second day,	10 to 1 ..	..	Engineering (1st Paper).
„	2.30 to 6	..	„ (2nd „).
Third day,	9.30 to 11.30	..	Municipal and Local Government Law.
„	12	..	*Vivâ voce* Examination.

The questions in each subject are divided into sections, as shown under "Subjects of Examination."

Candidates at home examinations may elect to be examined in either English, Scottish, Irish, or Metropolitan Law. Colonial Law or English Law may be taken at Colonial Examinations.

Candidates must attempt one question in each section, but must not attempt more than six questions in each subject. In the case of Municipal Law, which is not divided into sections, not less than four questions must be attemptod. There is no *vivâ voce* examination in Municipal Law.

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The *vivâ voce* examination of Relegated and Colonial candidates takes place during the course of the written papers.

No information as to the result of an Examination, beyond the fact of a candidate having "Passed" or "Failed," or having been "Relegated," is given.

Questions set at Examinations held prior to 1902 can only be obtained in the volumes of the "Proceedings." On sale by Messrs. E. & F. N. Spon, Ltd., Publishers, 57 Haymarket, S.W. The questions set at subsequent examinations are not published.

Any inquiries referring to the Examinations should be directed to Mr. Thomas Cole, Secretary to the Institution, 11 Victoria Street, London, S.W., and should be accompanied by an addressed foolscap envelope.

SUBJECTS OF EXAMINATION.

I.—Engineering as applied to Municipal Work: 1st Paper:

A. Sewage Disposal.
B. Tramways Construction.
C. Bridge Construction.
D. Water Supply.

II.—Engineering as applied to Municipal Work: 2nd Paper:

A. Geodesy.
B. Hydraulics.
C. Sewerage.
D. Road Construction and Maintenance.

III.—Building Construction: Strength of Materials:

A. Materials.
B. The Construction of Public and Private Buildings.
C. Building Bye-laws.
D. Public Baths and Hospitals.

IV.—Sanitary Science as applied to Towns and Buildings:

A. Heating and Ventilation.
B. Scavenging and Disposal of Refuse.
C. Water Supply and Drainage of Buildings.
D. Disinfection.

V.—Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Note.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

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EXAMPLES OF QUESTIONS.

The following questions have been compiled from Examination Papers set to Candidates, and serve as examples of the questions asked under the different sections.

DIRECTIONS.—"You are particularly requested to write legibly, and to answer the questions as concisely as possible. *Fill in your number where indicated, also at the top of every book handed in. Prefix the number of the question to each answer. Place this question-paper inside your book before handing it in.* Wherever possible, freehand sketches or diagrams should be drawn to illustrate the answer; these should be carefully executed, as they will be taken as showing the Candidate's proficiency in this style of drawing. Candidates must not, during the examination, refer to any books or manuscript, or communicate with each other. Slide rules may not be used."

I. SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

(Candidates must attempt one question in each section, but not more than six in all.)

FIRST PAPER.

(*Time allowed, 3 hours.*)

SECTION A. SEWAGE DISPOSAL.

1. Describe briefly the various systems of treatment now in use at outfall works; explain their general principles, advantages, and disadvantages.
2. Describe an up-to-date system of sewage disposal suitable for a district of 10,000 population, taking a dry-weather flow of 40 gallons per head per day, and state how you would deal with storm water. Give dimensions wherever possible.
3. A series of settling tanks are to be constructed, each to contain 250,000 gallons. State the dimensions you suggest for one of such tanks, and give sketch, plan and sections showing the form of bottom you suggest, and the position of inlets and outlets, and how same should be formed.

SECTION B. TRAMWAYS CONSTRUCTION.

4. Sketch and describe the various kinds of tramway rail joints in use for electric traction, stating their respective advantages and disadvantages. Design an ordinary fish-plate joint, and point out the features to which you consider special attention should be paid.

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5. Sketch the cross-section of a road 32 ft. wide between kerbs, one side being 1 ft. lower than the other, with double track tramway, 3 ft. 6 in. gauge; show, in figures, the "cambering" of the road, when paved the whole width with stone setts, or Jarrah wood, and also when the tramway is paved with setts, and the remainder of the road macadam.

6. Sketch a "turn out" or "passing place" on a single line of tramway, figure the leading dimensions, the angle of the crossings, and describe the length, position and character of the "points" required for diverting the traffic.

Section C. BRIDGE CONSTRUCTION.

7. Work out the strains on a wrought-iron girder (sketch given) 56 ft. span 7 ft. high, and give figured sections of flanges, struts and ties. Distributed load 200 tons.

8. State the live load per foot run of paths and carriageway you would allow for in the case of a bridge, 60-ft. span, with a carriageway 36 ft. wide, and 12-ft. paths on each side.

   The bridge has two lines of tramway, 4 ft. 8½ in. gauge, to carry cars weighing 5 tons when loaded, the distance between the two wheel axles being 18 ft.

9. A bridge has to be constructed to carry a 60-ft. street over a canal, the clear span being 40 ft., the minimum head room being 11 ft. at centre and 9 ft. at sides above normal water-level: the approaches are rising gradients of 1 in 24 and 1 in 90 respectively. Sketch the bridge you recommend for such a position, giving all important particulars, short specification tests for materials, and tests for bridge when completed.

Section D. WATER SUPPLY.

10. What percentage of total annual rainfall over a watershed would you expect to have available for storage? State locality and characteristics of the watershed to which your answer relates.

11. A covered reservoir is required to serve a town of 5000 inhabitants. Sketch and describe the reservoir you would adopt, giving all requisite details, and assuming your own conditions of site and foundation. Give a short specification of the necessary works, tests for materials, and an estimate of cost.

12. Sketch and describe a small pumping station capable of lifting daily 100,000 gallons of water from a borehole in the rock and delivering through a rising main 500 yards long into a reservoir, the total vertical lift being 100 ft. After working out the theoretical horse-power required, state the brake horse-power and type of engine you recommend, and give your reasons.

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II. Subject:—ENGINEERING as applied to Municipal Work.

(Candidates must attempt one question in each section, but not more than six in all.)

SECOND PAPER.

(Time allowed, 3½ hours.)

Section A. GEODESY.

1. Describe the mode of making a land survey with the chain only, and with the usual instruments, and explain the advantages of the latter method. Describe the instruments, and give an illustration of a "field-book" with imaginary entries therein.

2. Make a sketch of the primary and vernier scales of a theodolite for reading to minutes. Explain the object of the vernier, and the principle upon which it works.

3. How would you proceed to contour and make a plan of a valley proposed to be used as an impounding reservoir? What is the advantage of a contour plan for this purpose?

Section B. HYDRAULICS.

4. The velocity in a 9-in. pipe, running full, laid at a gradient of 1 in 48, is 352 ft. per minute. Give the velocities in such a pipe when laid at the following gradients: 1 in 16, 1 in 96, and 1 in 432.

5. A pumping main a mile in length is required to discharge 600 gallons per minute at a velocity of 3 ft. per second. What diameter pipe is necessary?

6. What do you mean by "hydraulic mean depth"? Why is the hydraulic mean depth the same in the case of a circular pipe flowing full or half full, supposing you agree that it is so?

Section C. SEWERAGE.

7. Describe the usual method of setting out the lines for the construction of a sewer, and the means that should be adopted to ensure that the invert shall be laid to the correct depth and gradient.

8. Make a detail sketch with figured dimensions of a storm overflow chamber on a 3 ft. by 2 ft. egg-shaped sewer, discharging when full 600 cubic ft. per minute, assuming that the storm overflow will come into operation when the sewage flowing is one-third the depth of the sewer.

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9. A circular sewer, 4 ft. internal diameter, is to be constructed with brickwork in open cutting, the invert being 15 ft. below the surface of the ground. Trial holes show 6 ft. of loose made ground, 4 ft. of clay, and 12 ft. of running sand resting on a thick bed of clay. Show by sketches the timbering of the trench and the construction of the sewer and give a description of the work and materials.

Section D. ROAD CONSTRUCTION AND MAINTENANCE.

10. Do you consider the stones in macadam should be all of one gauge, or do you prefer varying sizes? State the reasons for your preference.
11. A macadamised carriageway 36 ft. wide has got into bad repair, and the whole surface requires to be recoated with stone for an average thickness of 3 in. Explain in detail the different operations necessary to carry out the repairs, including rolling, and give the cost per yard of each operation, assuming that the cost of the stone delivered on the road is 12*s.* 6*d.* per ton, binding material 3*s.* 6*d.* per ton, and labour 5*d.* per hour.
12. Give a brief description and express your opinion of any methods of road construction and treatment with which you are familiar for the prevention of dust caused by motor traffic.

III. Subject:—BUILDING CONSTRUCTION.

(Candidates must attempt one question in each section, but not more than six in all.)

(*Time allowed, 4 hours.*)

Section A. MATERIALS.

1. State what you know of the various timbers used in building, and what class of work and situation they are each adapted for.
2. State the crushing and safe working loads of any brickwork with which you are acquainted, describing the brickwork.
3. Explain, as far as you can, the different characteristics and chemical composition of common lime, hydraulic lime, Roman cement, Portland cement, and Keene's cement.

Section B. THE CONSTRUCTION OF PUBLIC AND PRIVATE BUILDINGS.

4. A girder, with a clear span of 30 ft., bears a uniformly distributed load of 40 tons; it is supported at one end by a wall and at the other by a hollow cast-iron column, circular in section. The column is 10 ft. in height with fixed ends. Give the dimensions of the column, with method of calculation.

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5. In the construction of a factory chimney specify the following:—
   (*a*) The subsoil being a stiff clay and weight of shaft 1000 tons, what area of concrete is it necessary to provide for foundation?
   (*b*) What proportion should the spread of the footings bear to the thickness of the brickwork at the base of the shaft?
   (*c*) In a shaft 200 ft. high, give the varying thickness of brickwork from base to cap, with distances between the various offsets and height of fire-brick lining.
   (*d*) What is the usual proportion of the diameter of base to the height of shaft (circular on plan)?
   (*e*) State the comparative advantages of circular, octagonal and square shafts with regard to wind resistance.
6. Sketch a concrete beam reinforced with steel rods to carry a distributed dead load of 20 tons with a clear span of 15 ft. Show your calculations.

Section C. BUILDING BY-LAWS.

7. State how the subsoil of the site of an intended new building should be drained, "where the dampness of the site renders such precaution necessary." Give sketch-plan of drains.
8. Describe fully the chief provisions for the prevention of the spread of fire from one house to another.
9. What information must be given to a sanitary authority by a person desirous of laying out a new street?

Section D. PUBLIC BATHS AND HOSPITALS.

10. Make a cross-sectional sketch of a public swimming bath, 44 ft. in width over all, showing the bath, dressing-boxes, gallery, and roof, with their several dimensions. Describe fully the means adopted for rendering the bath water-tight, and give the type of roof.
11. In designing an isolation hospital for 100 beds, shortly describe the following provisions, viz.:—
    Number and extent of ward blocks.
    Nature of other buildings necessary for administration purposes.
    Proportion of floor space per bed.
    Proportion of cubical space per bed.
    Method of ventilation to be adopted in wards.
    Method of heating to be adopted in wards.
12. In designing public baths, comprising, say, a swimming bath 70 ft. × 30 ft., ten slipper baths, and a small laundry, what method would you adopt to heat the water, and how would you warm the building?

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IV. Subject:—SANITARY SCIENCE as applied to Towns and Buildings.

(Candidate must attempt one question in each section, but not more than six in all.)

(*Time allowed*, 3 *hours*.)

Section A. HEATING AND VENTILATION.

1. Explain what you mean by "natural" and "artificial" ventilation. Illustrate your answer by sketches of each as applied to a public building or school. What are the advantages and disadvantages of each system?
2. In preparing a scheme for warming a building, what are the recognised methods of calculating the amount of heating surface required for varying temperatures?
3. Describe concisely three different methods of ventilating sewers, expressing your views as to their merits or otherwise.

Section B. SCAVENGING AND DISPOSAL OF REFUSE.

4. Describe the method you would adopt for collecting—
   (*a*) The contents of cesspools.
   (*b*) Excreta in pails.
   (*c*) Offal.

   And give particulars of the vehicle you would recommend in each case.
5. Describe the essential features of a good type of refuse destructor, and give a section of the same.
6. Describe the most satisfactory means of
   (*a*) Removing house refuse
   (*b*) Cleansing ashpits and privies

   where the local authority undertake the work of removal.

Section C. WATER SUPPLY AND DRAINAGE OF BUILDINGS.

7. Describe the construction of a hot-water service for bath and other purposes in a house. Describe how the circulation is obtained, and show, by a diagram, the position of the boiler, cistern, cylinder, etc., and state the precautions that should be taken to prevent damage by frost.
8. State shortly what are the general principles of efficient house drainage, and give a few examples of how these are frequently disregarded in actual practice.
9. What kind of water acts upon lead? State the risk attendant upon its use and the means you would adopt for avoiding or reducing such risk.

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SECTION D. DISINFECTION.

10. Mention the various disinfectants in common use, and state which you consider the best for particular purposes. Describe the methods of use and the precautions necessary.

11. What are the points to be observed in the selection of the necessary apparatus to effect the proper disinfection of bedding and clothing? Give a brief description of the apparatus with which you are acquainted.

12. Describe how you would proceed to disinfect a house after the following diseases: (*a*) scarlet fever, (*b*) typhoid fever, (*c*) diphtheria, (*d*) small-pox.

V. SUBJECT:—MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL AND COUNTY ENGINEERS AND SURVEYORS.

(England)

(Candidates must attempt at least four questions.)
(*Time allowed*, 2 *hours*.)

1. Under what Act can a local authority make by-laws as to deposit of plans for alterations to existing buildings, and to what buildings do these by-laws apply?

2. What are the conditions under which a manufacturer may discharge his trade refuse into the sewers of a local authority?

3. Can a local authority compel a proper supply of water to be laid on to premises, and if so, under what conditions in (*a*) urban districts, (*b*) rural districts? State the mode of procedure in each case.

4. The surveyor to a local authority has reported to him (*a*) a dangerous building abutting on a public highway, and (*b*) a dangerous chimney on private enclosed premises. State what are his powers and duties in each case, and set out fully the proceedings he would take in proper sequence.

5. An occupier refuses to allow his premises to be entered by the assistants of the surveyor to a local authority for the purpose of taking levels: what course is prescribed by statute to meet such a case?

6. State which Acts give powers respecting tramways and light railways, and describe the principal differences between them, particularly as to position of tramway in road, spaces, notices, supervision, and mode of procedure.

7. Describe the provisions of the Buildings in Streets Acts, 1888, and point out in what respect they differ from the previously existing powers.

8. What rights have owners and occupiers of property to connect their drainage with the sewers of a local authority (*a*) within the district, (*b*) without the district? (*c*) under what restrictions can the connections be made? and (*d*) what are the penalties for non-compliance?

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9. Give two instances where you consider the present Public Health and Sanitary Acts or Highways Acts are defective or require amendment, and in what way would you remedy these defects?

This question is intended to elicit answers from candidates as to any difficulties they may have experienced or observed or heard of in carrying out the duties of a surveyor.

10. What is a Provisional Order, and when is it usually applied for? Compare it with a local Act of Parliament, specifying its chief advantages. State the nature of Provisional Orders issued by the Board of Trade as distinct from the Local Government Board.

11. Give reasons for recommending a council to adopt the Private Street Works Act, 1892. State also the disadvantages of that Act compared with sections 150 and 152 of the Public Health Act, 1875.

12. What powers have local authorities with respect to—

(*a*) Planting of trees in highways?
(*b*) Underground conveniences?
(*c*) Sanitary conveniences for manufactories?
(*d*) Ingress to and egress from places of public resort?
(*e*) Safety of platforms on public occasions?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW

AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Scotland)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. Define the various roads to which these words apply, viz., Highway, Turnpike Road, Statute Labour Road, as interpreted by the Roads and Bridges (Scotland) Act, 1878.

2. Describe the statutory provisions whereby a local authority can recover from any person expenses for damage to highways caused by extraordinary traffic thereon, or by excessive weight passing along the same; and state in what Act of Parliament these provisions are embraced.

3. To whom must application be made for authority to lay out new streets? Specify the details which require to be shown on the plan accompanying the application.

4. If a Burgh should desire to improve any existing private streets, what statutory procedure would be necessary?

5. What are the powers of a Burgh with reference to the keeping of footpaths of public streets in proper repair? How far do these powers apply to private streets?

6. Specify the procedure which must be adopted in a Police Burgh before a public sewer can be laid. Under what Act is this necessary?

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7. What powers of entry are given under the Public Health (Scotland) Act for the purpose of examining drains, and what is the necessary procedure?

8. Specify the duty of a Local Authority with reference to the water supply of buildings in an isolated district.

9. Enumerate the powers given for the formation of special water supply districts. State briefly under what circumstances a Local Authority is bound to take action.

10. What were the requirements of the 1892 Burgh Police (Scotland) Act with regard to back space for proposed buildings, and what alteration was made by the 1903 Act?

V. MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Ireland)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. What provisions are made under the Public Health (Ireland) Act, 1878 (Section 50), with regard to drains, water-closets, sinks, lavatories, gulley traps, earth closets, privies, ashpits, and cesspools?

2. What extended meaning is given to the word "ashpit" in the Public Health Act of 1890?

3. How would a cesspool require to be constructed to comply with the provisions of the Public Health (Ireland) Act, 1878?

4. By whom, and under what conditions under the Public Health (Ireland) Act, 1878, can—
   (*a*) A drain be connected with a public sewer?
   (*b*) A service pipe be connected with a water main?

5. Under what conditions could a closing Order be obtained for a house or building—
   (*a*) Under the Public Health (Ireland) Act, 1878?
   (*b*) Under the Housing of the Working Classes Act, 1890?

6. What locomotives are exempted by the Locomotives on Highways Act, 1896, from the restrictions of other Public General or Local and Personal Acts in force at the passing of the 1896 Act?

7. Can the jurisdiction of a County Council with regard to roads be transferred to an Urban District Council; if so, what procedure is necessary and under what Act should it be taken?

8. What restriction is there under the Summary Jurisdiction Act as to the distance at which a building can be erected from the centre of a road?

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V. MUNICIPAL AND LOCAL GOVERNMENT LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Metropolitan)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. Describe the legal formalities and proceedings incident to and the carrying out of Private Street Works under the provisions of:—
   (*a*) The Metropolis Local Management Act, 1855.
   (*b*) The Metropolis Local Management Act, 1862.
   (*c*) In what important particular does the Metropolis Management Amendment Act, 1890, differ from the last-named statute?

2. How is a right of light acquired? Can you name any important decision of the High Courts affecting the matter? What was established by the House of Lords in the case of *Colls* v. *Home and Colonial Stores, Ltd.*?

3. Explain the terms, Mis-feasance and Non-feasance. What do the following expressions mean as defined by the Public Health (London) Act, 1891?
   (*a*) Trade Refuse.
   (*b*) House Refuse.
   (*c*) Street Refuse.
   (*d*) Rack Rent.
   (*e*) Sanitary Convenience.

   Is the refuse of a restaurant house refuse or trade refuse?

4. A Metropolitan Borough desires to construct an underground convenience in a public highway. What statutory powers are vested in the local authority to provide such a convenience? May they use any portion of the public footpath for such a purpose, and do you know of any recent case bearing on the point?

5. What powers are vested in the London County Council to deal with dangerous buildings?

6. Explain the difference between a Public and a Private nuisance.

7. What is a combined drain? Give a definition of "Drain" as applicable to the Metropolis.

8. It is proposed to widen a street in the Metropolis and to acquire the necessary property compulsorily. How is this legally effectuated? Describe procedure.

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V. COLONIAL LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(India)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. Under what circumstances may the local authority lay a sewer without notice.
2. What right of drainage have the owners of any premises—
   (*a*) Into a public sewer,
   (*b*) Into a private drain ?
3. Under what circumstances may a Municipality refuse to pay compensation when requiring a building to be set back to improve a street ?
4. State the procedure to be followed when an owner proposes to lay out a new street :—
   (*a*) By the Municipality.
   (*b*) By the owner of the land.
5. Describe the action of the Municipality with regard to dangerous buildings—
   (*a*) When the danger is proximate.
   (*b*) When it is imminent.
6. State precisely the difference between the action to be taken when land is likely to be needed, and when it is required for a public purpose.
7. Show circumstances under which the possession of land may be obtained before any award has been made under the Land Acquisition Act.
8. Discuss the matters which may and which may not be taken into consideration when making an award under the Land Acquisition Act.

(BOMBAY CANDIDATES ONLY.)

9. At whose cost is the water service pipe to a house laid and to whom does it belong ?
10. Discuss the procedure regarding—
    (*a*) A structure erected to overhang a street.
    (*b*) Placing a stall, ladder, etc., upon any street.
    (*c*) Setting up a scaffold, etc.
11. State the reasons why a building proposal may be disapproved.
12. Are there any provisions of the Municipal Act which, in your opinion, require amendment?

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V. COLONIAL LAW, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

(Africa)

(Candidates must attempt at least four questions.)

(*Time allowed, 2 hours.*)

1. Define the terms Dwelling, Drain, Sewer, and Street, as employed in "The Public Health Amendment Act, 1897," and By-laws thereunder.
2. Under what Act or Acts can an Urban Local Authority frame Regulations for regulating and controlling the erection of new buildings?
3. What are the powers of an Urban Local Authority with reference to the regulation and control of the slaughtering of animals for food and the provision of Public Slaughter Houses? State the procedure to be followed in bringing these powers into operation.
4. Several private landowners within the area of a Municipality constituted under the "Municipal Act, 1882," intend selling their land in divided portions or building lots. What are the powers which the Municipality possesses, or can acquire, with reference to ensuring that the plots are of sufficient size, and, generally, that the land and proposed new streets are properly laid out? What procedure should the Municipality follow in bringing their powers into operation?
5. What are the powers of an Urban Local Authority with reference to dwellings which are unsafe or unfit for human habitation? State the procedure to be followed in dealing with such a dwelling.
6. What powers has a Municipality to summarily remove accumulations of filth after short notice to the owner or occupier?
7. What are the borrowing powers:—
   (*a*) Of Municipalities constituted under the "Municipal Act, 1882."
   (*b*) Of Boards constituted under the "Villages Management Act, 1881"?
8. A Municipality constituted under the "Municipal Act, 1882," desires to carry out a Sewerage Scheme. Part of the proposed outfall sewer of the proposed site of the disposal works are outside the Municipal area, and the Municipal Council is unable to come to any arrangement with the landowners concerned. What power does the Municipality possess in this connection, and what is the procedure?
9. What enactment entitles an owner or occupier of premises to cause his drains to empty into the sewers of an Urban Local Authority, and what conditions govern the exercise of such powers?

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BOARD OF EXAMINERS.

THE PRESIDENT OF THE INSTITUTION (*ex-officio*).

J. P. BARBER, M. Inst. C.E.
W. NISBET BLAIR, M. Inst. C.E.
J. A. BRODIE, M. Eng., Wh. Sc., M. Inst. C.E.
C. BROWNRIDGE, M. Inst. C.E.
J. BRYCE, A.M. Inst. C.E.
J. COCKBILL, M. Inst. C.E.
A. E. COLLINS, M. Inst. C.E.
H. A. CUTLER, M. Inst. C.E.
A. T. DAVIS, M. Inst. C.E.
R. H. DORMAN, M. Inst. C.E.
W. DYACK, M. Inst. C.E.
A. M. FOWLER, M. Inst. C.E.
A. D. GREATOREX, M. Inst. C.E.
G. GREEN, A.M. Inst. C.E.
CHAS. JONES, M. Inst. C.E.
JAMES LEE.
SIR JAMES LEMON, M.Inst.C.E., F.R.I.B.A.
JOS. LOBLEY, M. Inst. C.E.
C. J. MULVANY, M. Inst. C.E., B.A. I. (Dublin).
JAMES PATON.
J. S. PICKERING, M. Inst. C.E.
W. H. PRESCOTT, A.M. Inst. C.E., Barrister-at-Law.
R. READ, A.M. Inst. C.E.
O. C. ROBSON, M. Inst. C.E.
H. E. STILGOE, M. Inst. C.E.
R. J. THOMAS, M. Inst. C.E.
H. T. WAKELAM, M. Inst. C.E.
W. WEAVER, M. Inst. C.E.
A. E. WHITE, M. Inst. C.E.
C. F. WIKE, M. Inst. C.E.
T. H. YABBICOM, M. Inst. C.E.

CANDIDATES WHO PASSED THE EXAMINATIONS HELD 1911–1912.

72nd Examination, October 1911.

K. C. Bannerjee.
N. N. Bose.
A. D. Braggins.
J. E. Cardell.
J. T. Dewhurst.
G. E. Fryer.
F. C. Jones.
W. A. Lavender.
G. O. Lockwood.
R. S. Macmillan.
J. S. McGlashan.
P. I. Payne.
Puran Mal.
J. T. Rothwell.
W. Slater.
H. C. Swindells.
C. D. H. Vanstone.

73rd and 74th Examinations, March 1912.

A. D. Barron.
C. D. Bright.
A. Clough.
O. H. Cockrill.
H. T. Davies.
W. H. Duckworth.
G. Dyke.
A. W. Edmett.
H. Elliott.
R. L. Fairclough.
H. S. Hall.
B. C. Hammond.
S. F. Hopley.
A. C. Hughes.
S. J. Kirby.
S. C. Lloyd.
W. T. Lynam.
H. J. Osborne.
A. Palmer.
S. Palmer.
E. Potts.
A. W. Scott.
B. N. Sharma.
H. V. Snook.
C. H. Walmisley.

75th Examination, April, 1912 (*South Africa*).

J. O. Parry.

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Memoirs of Deceased Members.

THE Council, having been requested to append some short notice of the decease of Members of the Institution, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these "Proceedings."

MR. LEWIS ANGELL was born on January 19, 1831, and died at Eastbourne on March 22, 1912. He was a student of the School of Design, Somerset House, under Stevens, the designer of the Wellington Monument in St. Paul's Cathedral; matriculated at King's College, obtained the diploma of "Associate," and was subsequently elected a Fellow of the College. He was articled to the late Mr. Richard Reynolds Rowe, architect, of Cambridge, and afterwards employed by the Corporation of Norwich, from whence he was appointed on the engineers' staff of the London and North Western Railway (1856).

Mr. Angell had a large experience at Westminster and in connection with municipal engineering, architectural, and Parliamentary works, including the Wandsworth (Metropolitan) Board of Works, the Corporations of Portsmouth, Margate, Maidstone, and West Ham; also Woodford, Epping, Harlow, and many other minor towns, in the erection of public buildings, town halls, a large county borough lunatic asylum (Chadwell Heath, Essex), hospitals, union workhouse, main drainage, sewage disposal, etc., the aggregate value of the works amounting to about a million sterling.

Mr. Angell was admitted a Fellow of the Royal Institute of British Architects in 1864 and a Member of the Institution of Civil Engineers in 1866. He was Vice-Chairman and

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Chairman of the Standing Committee on Science of the Royal Institute of British Architects, and for many years a statutory examiner under the Metropolitan Building Acts, and a Fellow, Member of Council, and an Examiner of the Sanitary Institute of Great Britain.

In 1870 he was elected Life Governor and Member of Council of the University College of Wales, Aberystwyth, was a Member of Council of the Social Science Association, and a Vice-President of its Congress at Liverpool in 1876. He was a Member of Council of the International Congress of Hygiene and Demography, London, 1891; President of the Engineering and Architectural Section of the Sanitary Congress at Leeds in 1897; and Vice-President of the Birmingham Congress in 1898. He also contributed various papers and promoted university extension lectures.

Mr. Angell joined the volunteer movement in its early days, and assisted in raising a company of the 1st Middlesex Engineers.

He was associated with Church work, and was for some twenty years an elected member of the St. Albans Diocesan Conference and a vicar's warden for the same period, for eleven years being warden for the present Bishop of Barking.

Mr. Angell was the Founder and first President (1873–4–5) of this Institution.

Mr. John Thomas Eayrs, formerly Borough Engineer of West Bromwich, and since his relinquishment of official work a consulting engineer at Birmingham, died on May 8, 1912, in the 57th year of his age. His demise will be a permanent loss to more than the immediate circle of family and friends, for he was known professionally to a very wide circle of engineers by reason of the active and influential part he always played in all questions affecting their interests. He was a shrewd and original thinker, a man of great personal charm and geniality of disposition, and—as many whom he has assisted can testify—an unselfish and devoted friend.

Mr. Eayrs was elected a member of this Institution in November, 1877, President 1893–4, and for many years took an active part in the examinations.

George Joseph Bell, County Surveyor and Bridge Master

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for Cumberland, died suddenly in his office at Carlisle on October 6, 1911, aged 75. Trained under the late Mr. Robert Bell, he became District Surveyor successively to the Brampton Highway Board and to the Isle of Axholme Highway Board. He held his last office over thirty years, having been appointed in 1879. He had charge of over 500 miles of main roads and of all county bridges in the county. He was an authority on skew arches for bridges, and built several in Cumberland on this principle.

Mr. Bell was elected a Member of the Institution in January, 1897.

Mr. William Diggle, who for the past twenty years occupied the position of surveyor to the Runcorn Rural District Council, died on January 3, 1912, at the age of sixty-two. Previous to this appointment he was surveyor to the West Eddisbury Highway Board, Cheshire. He had been in failing health for only a short time. He was advised to undergo an operation, successfully performed, but acute bronchitis set in, which caused his sudden end, which was a great shock to his fellow-men. The deceased gentleman was held in high esteem by his Council and ratepayers generally. He was elected a Member of the Institution in September, 1889.

George Heaton, born at Pemberton, near Wigan, on February 7, 1840, died at Wigan on October 8, 1910. Trained under the late Mr. J. L. Hunter, he was first employed by the Wigan Corporation and the late Sir Robert Rawlinson, and afterwards started as a consulting engineer at Wigan, continuing to practise until his death. He was responsible for waterworks, sewerage systems, public buildings, cemeteries, street improvements, tramways, and other works, in Wigan and many of the neighbouring townships. Mr. Heaton was elected a Member of this Institution in May, 1885.

Mr. John Arthur Hoyle, formerly deputy borough engineer, Blackburn, was born on February 10, 1883, and died on May 16, 1912. He received his training under Mr. J. Singleton Green of Haslingden, and was engaged on the main drainage and other important works, including an installation of electric tramways. He held the Institution's Testamur, and was elected a graduate

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in May, 1907, Associate Member in 1908, and full Member of the Institution in July, 1911.

MR. PATRICK JOHN LYNAM, county surveyor of Louth, died after a long and painful illness on August 7, 1912, in his sixty-first year. Mr. Lynam was educated at Queen's College, Galway, and in due course joined the Indian Civil Service, in the discharge of the duties of which he spent some years in Ceylon. Returning to Ireland some thirty years ago, he was appointed county surveyor of Mayo, and subsequently county surveyor of Louth under the Grand Jury since superseded. Among the important works he carried out was the building of the new courthouse at Drogheda. Latterly he did everything in his power to improve the county roads by means of steam rolling, which is not yet general in Ireland. Mr. Lynam was elected a Member of the Institution in August, 1891.

MR. EDGAR IVEAGH LORD, borough engineer, Greymouth, New Zealand, died on March 21, 1911, aged sixty-eight. Mr. Lord was educated at the High School, Hobart, and received his training under Mr. H. P. Sorrell. From 1866 to 1885 he was employed as authorised surveyor under the New Zealand Government, after which he went into private practice. In 1888 he was appointed borough surveyor of Greymouth, and in that capacity he designed and carried out the waterworks and several other important works in the borough. Mr. Lord was elected a Member of the Institution in November, 1902.

MR. W. J. PRESS, for some years surveyor to the Burnham (Somerset) Urban District Council, and since his retirement a Member of the U. D. Council. He was elected a Member of the Institution in January, 1892.

MR. THOMAS HENRY TARBIT, surveyor and sanitary inspector to the Loftus (Yorks) Urban District Council. He was elected a Member of the Institution in March, 1895.

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

LIST OF COMMITTEE AND OFFICERS, 1911–12.

Committee:

MR. A. D. GREATOREX (President).
MR. J. PATTEN BARBER.
MR. W. NISBET BLAIR.
MR. A. H. CAMPBELL.
MR. J. W. COCKRILL.
MR. C. H. COOPER.
MR. W. HARPUR.
MR. E. PURNELL HOOLEY.
MR. C. JONES.
MR. W. H. LEETE.
MR. H. RICHARDSON.
MR. R. J. THOMAS.
MR. E. WILLIS.

Trustees:

MR. J. T. EAYRS.
MR. O. CLAUDE ROBSON.
MR. T. H. YABBICOM.

Hon. Secretary and Hon. Treasurer:

MR. O. CLAUDE ROBSON,
Municipal Offices,
Dyne Road, Kilburn, N.W.

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

July 11, 1912.

To the Subscribers to the Orphan Fund of the Institution of Municipal and County Engineers.

GENTLEMEN,

Your Committee beg to report that whilst but little improvement can be recorded in connection with the subscriptions received towards the fund during the year ended December 31, 1911, they are nevertheless pleased to report that no serious diminution occurs in the annual income during the year, the amount subscribed having been 128*l.* 5*s.* as compared with 144*l.* 1*s.* 9*d.* in 1910, whilst the number of subscribers has been 140, or 3 less than in the preceding year.

Every endeavour has been made by circular or otherwise to augment the numbers of subscribers to the fund, so that the list may show a better proportion to the numbers enrolled upon the books of the Institution, but unfortunately the numbers remain very similar to those of previous years. It is, however, satisfactory to report that those members falling out are made good by new subscribers, so that the list is but slightly reduced, whilst it has been found possible to provide grants to all those applying, to invest a further 50*l.* in London County Stock, and to carry forward a balance of 120*l.* 1*s.* 1*d.*

The grants made have rendered assistance to six widows of late Members of the Institution towards the schooling and maintenance of their children, whilst one child still remains at the British Orphan Asylum, for which a presentation was purchased on May 15, 1909, for a period of seven years. Thus it has been possible for your Committee to provide assistance towards the maintenance of thirteen children during the year,

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and they have also been enabled to satisfy all claims of a justifiable character that have been made upon the fund.

The market value of the stock invested at the end of the year was somewhat less than at a similar period in 1910, but owing to an additional investment during 1911 the dividends received were slightly more. The balance sheet on p. 511 summarises the condition of the fund at the end of the year 1911, viz.—

The amended Title of the Institution of Municipal and County Engineers, necessitated a similar alteration in the Title of the Fund, which was duly effected at a Special General Meeting of Subscribers held on August 18, 1911, and the Rules and Regulations governing the Fund were altered accordingly.

Your Committee have to express their regret at the lamented death of the late Mr. J. T. Eayrs, who had been a Trustee of the Fund from its inception, and had at all times taken an earnest and generous interest in its work. It will be necessary by Rule 26 to appoint a new Trustee in his place, for which purpose a Special General Meeting of the Subscribers will be held after this meeting.

Your Committee append list of the Subscribers to the Fund at the end of the year 1911, and would take this opportunity to again express their thanks to the Secretaries of the various Districts for the assistance they have at times rendered towards augmenting the Fund by application for subscriptions at the various District Meetings. Your Committee attach some importance to this method of increasing the number of Subscribers to the Fund, and sincerely trust that renewed endeavours will be made at future meetings in this direction, and that the subscribers themselves, in addition to their own generous action in connection with the Fund, will do their best to induce their friends and brother engineers to follow their example.

A. D. GREATOREX,
CHAIRMAN.

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CASH ACCOUNT FOR THE YEAR ENDING DECEMBER 31, 1911.

Dr. *Cr.*

	£	s.	d.		£	s.	d.
Balance brought forward, January 1, 1911	115	18	5	Grants to Orphans	108	15	0
Donations	23	6	6	Postages, Printing and Sundries	5	12	9
Subscriptions	104	18	6	Purchase of £56 14s. 6d. London County 3 per cent. Consolidated Stock	50	0	0
Interest on £148 Portsmouth Corporation 3½ per cent. Stock	4	17	6	Balance	120	1	1
Interest on £232 L. & N. W. Rly. 3 per cent. Debenture Stock	6	11	0				
Interest on £100 West Ham Corporation 3½ per cent. Stock	3	1	4				
Interest on £264 15s. 4d. Consols, 2½ per cent. ..	6	4	8				
Interest on £465 14s. 10d. London County 3 per cent. Stock	12	15	4				
Return of Income Tax (4 years ending March, 1911)	6	15	7				
Total	£284	8	10	Total	£284	8	10

GROSS ASSETS.

	£	s.	d.
Balance on Current Account	120	1	1
London and North Western Railway Stock	196	0	10
Portsmouth Corporation Stock	146	10	5
West Ham Corporation Stock	91	0	0
Consols	204	4	0
London County Stock	393	11	0
Total	£1151	7	4

Examined and approved.

WOOD, DREW & CO.,
Chartered Accountants.

LONDON, 6 & 7, QUEEN STREET, E.C., May 29, 1912.

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INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS' ORPHAN FUND.

LIST OF DONATIONS AND SUBSCRIPTIONS FOR THE YEAR ENDED DECEMBER 31, 1911.

Name.	Donation.			Annual Subscription.			Total Contribution.		
	£	s.	d.	£	s.	d.	£	s.	d.
Angell, L., Eastbourne				1	1	0	1	1	0
Barber, J. Patten, Islington				1	1	0	1	1	0
Barrett, E. J., Staines				0	10	6	0	10	6
Beaumont, A., Beverley				1	1	0	1	1	0
Beaumont, G. E., Grenoside				1	1	0	1	1	0
Bell, G., Swansea				0	10	6	0	10	6
Beulah, J., Brigg	0	10	0				0	10	0
Biggs, Mrs. R., Richmond				0	10	6	0	10	6
Blair, W. N., St. Pancras				1	1	0	1	1	0
Block, E. H., Westminster	0	1	0				0	1	0
Brierley, J. H., Richmond				0	10	6	0	10	6
Brodie, J. A., Liverpool				1	1	0	1	1	0
Brodie, J. S., Blackpool				1	1	0	1	1	0
Brown, A., Nottingham				1	1	0	1	1	0
Brown, R., Southall-Norwood				0	10	6	0	10	6
Burn, W., Sutton-in-Ashfield				0	5	0	0	5	0
Burton, A., Stoke-on-Trent	0	10	6				0	10	6
Busbridge, T. A., Maidstone				0	10	6	0	10	6
Butt, E. E. W., Birmingham				0	5	0	0	5	0
Campbell, A. H., Edinburgh				1	1	0	1	1	0
Card, H., Lewes				0	10	6	0	10	6
Chowins, W. H., Burnham				0	10	0	0	10	0
Clare, J., Sleaford				0	5	0	0	5	0
Clarry, W. A. H., Sutton Coldfield ..				0	10	6	0	10	6
Clarson, H. J., Tamworth				0	5	0	0	5	0
Clews, C. A., Derby				0	10	0	0	10	0
Coales, H. F., Sunbury-on-Thames ..				0	5	0	0	5	0
Cockrill, J. W., Great Yarmouth ..				1	1	0	1	1	0
Cole, T., Westminster				1	1	0	1	1	0
Coleby, H. J., Atherstone				0	5	0	0	5	0
Collins, A. E., Norwich				1	1	0	1	1	0
Collis-Adamson, A. C., Highgate ..				0	5	0	0	5	0
Cook, F. C., Nuneaton				0	10	6	0	10	6
Cook, F. P., Mansfield Woodhouse ..				1	1	0	1	1	0
Cooper, C. H., Wimbledon				1	1	0	1	1	0
Cooper, F. A., Colombo, Ceylon ..	1	1	0				1	1	0
Cooper, L. A., Chiswick				0	10	6	0	10	6
Currall, A. E., Solihull				0	10	6	0	10	6
Davis, A. T., Shrewsbury				1	1	0	1	1	0
Dickinson, R., Berwick-on-Tweed ..				0	5	0	0	5	0
Diver, D. J., Marple				0	10	6	0	10	6
Douglas, S., Kenilworth				0	10	6	0	10	6
Dunn, J., Cambridge				0	10	0	0	10	0
Elford, E. J., Southend-on-Sea ..				1	1	0	1	1	0
England, J., Wrexham				0	10	6	0	10	6
Farrington, W., Woodford				1	1	0	1	1	0
Fiddian, W., Stourbridge				1	1	0	1	1	0
Finch, A. R., Kensington				1	1	0	1	1	0
Frost, H., Gosport				0	10	6	0	10	6

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Name.	Donation.			Annual Subscription.			Total Contribution.		
	£	s.	d.	£	s.	d.	£	s.	d.
Gamble, S. G., Southwark				0	10	6	0	10	6
Giles, H. A., Westminster				0	5	0	0	5	0
Gladwell, A., Slough				1	1	0	1	1	0
Goodyear, H., Colchester				0	5	0	0	5	0
Grant, F. T., Gravesend				0	10	6	0	10	6
Greatorex, A. D., West Bromwich ..				1	1	0	1	1	0
Green, G., Wolverhampton				1	1	0	1	1	0
Guilbert, T. J., Guernsey				1	0	6	1	0	6
Gunnis, J. W., Longford, Ireland ..				1	1	0	1	1	0
Harpur, W., Cardiff				1	1	0	1	1	0
Hart, G. A., Leeds				1	1	0	1	1	0
Hayward, T. W. A., Battersea				1	1	0	1	1	0
Heath, J., Urmston				0	5	0	0	5	0
Hellawell, O., West Didsbury				0	10	6	0	10	6
Higgens, T. W. E., Chelsea				1	1	0	1	1	0
Hooley, E. Purnell, Nottingham ..				1	1	0	1	1	0
Horton, J. W., Derby				0	10	6	0	10	6
Howard, H., Littlehampton				0	10	6	0	10	6
Humphreys, H. H., Westminster ..				1	1	0	1	1	0
Hurst, W., Westminster	0	1	0				0	1	0
Hutton, S., Exmouth				0	10	6	0	10	6
James, A. C., Grays				1	1	0	1	1	0
Jenkin, C. J., Finchley				0	10	6	0	10	6
Jones, Lt.-Col. A. S., Finchhampstead ..				1	1	0	1	1	0
Jones, C., Ealing				1	1	0	1	1	0
Jones, H. O., Folkestone				0	5	0	0	5	0
Killick, P. G., Finsbury				1	1	0	1	1	0
Lacey, G. W., Oswestry				0	10	6	0	10	6
Lancashire, W. T., Leeds				1	1	0	1	1	0
Leete, W. H., Bedford				1	1	0	1	1	0
Lemon, Sir J., Southampton				1	1	0	1	1	0
Lovegrove, E. J., Hornsey				1	1	0	1	1	0
Lower Thames Valley District Surveyors' Association				1	1	0	1	1	0
MacBrair, R. A., Lincoln				0	10	6	0	10	6
Mansergh & Sons, Westminster				2	2	0	2	2	0
Massie, F., Wakefield				1	1	0	1	1	0
Mawbey, E. G., Leicester				1	1	0	1	1	0
Maybury, H. P., Maidstone				1	1	0	1	1	0
Maylan, S., Basford				0	10	6	0	10	6
Meade, T. de C., Manchester				1	1	0	1	1	0
Norris, J. H., Godalming				0	10	0	0	10	0
Oakden, R. (junr.), Newark				0	10	6	0	10	6
Palmer, P. H., Hastings				1	1	0	1	1	0
Perkins, J., Birmingham				0	5	0	0	5	0
Pickering, J. S., Cheltenham				0	10	6	0	10	6
Platt, S. S., Rochdale				1	1	0	1	1	0
Price, A. J., Lytham				0	10	6	0	10	6
R. A. O. W. C's.	1	11	6				1	11	6
Read, R., Gloucester				1	1	0	1	1	0
Renwick, R. Horsham	0	5	0				0	5	0
Richardson, F. W., Aston Manor ..				1	1	0	1	1	0
Richardson, H., Handsworth				1	1	0	1	1	0
Robson, O. Claude, Willesden				1	1	0	1	1	0
Rogers, W. E., Rugeley				0	10	6	0	10	6
Rushbrooke, A., Willesden	0	2	6				0	2	6

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